Climate Change Adaptation Report

National Grid Gas
Gas Transmission and Distribution UK

September 2010

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THE POWER OF ACTION

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Contents

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1. EXECUTIVE SUMMARY

Following a direction to report issued in March 2010 by Defra under the Climate Change Act 2008, National Grid is part of the first phase of adaptation reporting. Separate Directions were issued to National Grid's two licensed businesses: **National Grid Electricity Transmission plc** and **National Grid Gas plc**.

National Grid supports the views of Climate Change science and believes that mankind contributes to a level of climatic change. National Grid also recognises that meeting the challenges of climate change is not only about reducing greenhouse gas emissions and developing a low-carbon economy but also ensuring that National Grid adapts to climate change such as; incremental hotter drier summers, warmer and wetter winters, coastal and river bed erosion and increasingly frequent extreme weather events such as floods.

National Grid owns National Grid Electricity Transmission plc and National Grid Gas plc. The former owns and operates the high voltage electricity transmission system in England and Wales. It is also the National Electricity Transmission System Operator (NETSO) which operates the Scottish high voltage transmission system and the offshore transmission system. The latter owns and operates the UK Gas Transmission system and the low pressure gas distribution in the heart of England distributing to approximately eleven million homes, offices and schools.

National Grid is at a very advanced stage of embedding its Climate Change policy for both mitigation and adaptation within the organisation, with climate change risks firmly embedded into our Risk Management process which is constantly reviewed and updated with appropriate actions and targets.

National Grid has risk assessed climate change adaptation against information drawn from UKCP09, and has chosen to assess its assets and processes against the high level scenario which is based on the least likely to occur prediction of climate change as of 2080. This was on the basis that should National Grid's assets and processes demonstrate resilience against this scenario it would inevitably be adapted against less significant and more likely climate change.

Analysis and experience has shown that energy infrastructure may be vulnerable to certain aspects of climate change, however the infrastructure has a significant degree of resilience to change, and therefore hence adaptation. In addition, technically it will be feasible to deal with adaptation issues over short, medium and long-term periods.

This risk assessment has indicated that overall National Grid Gas plc's assets and processes are resilient to climate change that is predicted to occur. Within this assessment there are some assets which require further assessment using more refined data. This will be an ongoing process which is already incorporated within National Grid's risk management process.

It is important to note that even where an asset is at a potential risk in this worst case scenario model, the risk is localised to the asset and the process it supports and hence is unlikely to lead to a loss of supply. None of the risks considered are likely to result in a risk to the system as a whole.

Over the past few years National Grid has worked alongside the Climate Scientists at the Met Office, Hadley Research Centre and other energy companies to better understand and prepare for the wider impacts of climate change on our electricity and gas assets and business operations. National Grid has and will continue to maintain relationships with relevant agencies to equip it with the capabilities of monitoring actual climatic developments and assessing the credible risks over the medium term.

As part of its response to the Direction, National Grid Gas plc has developed a process based on using Specific Physical Characteristics. These Characteristics were developed using data from the UKCP09, the Met Office and National Grid Gas plc engineers with the aim of allowing greater focus on key risk areas.

Each of these characteristics was assessed against the key assets and processes for National Grid Gas plc Transmission and Distribution. The initial risk assessment had four outputs: green –no material risk,

yellow – a currently controlled risk, amber – a risk requiring further information, red – a significant and not currently controlled risk.

The key findings of the analysis were as follows:

- As the majority of National Grid Gas plc's assets are underground they are naturally protected from the majority of effects of climate change. As these assets are critical energy delivery assets a high degree of general resilience is built into them and the processes they are managed under. This helps to mitigate any impacts that could be experienced as a result of climate change.

- The key risks that National Grid Gas plc needs to manage as a result of the risk assessment are:
  a. Ground movement fracturing on its ageing low pressure network assets
  b. River erosion
  c. Flooding of critical sites
  d. Temperature rises for Transmission compressor stations
  e. Assets located which are reliant on 3rd parties structures (e.g. bridges).

- Although both the Transmission and Distribution networks show a high degree of resilience it can be seen that there is greater resilience built into the Gas Transmission network compared to the Gas Distribution network. This is to be expected due to the critical national impact of the Transmission network compared to the more localised impact of the Distribution network.

- Through National Grid Gas plc's asset management processes the material risks are being managed and regularly monitored through existing business processes. In many cases the risks have already been experienced and mitigation measures are in place to manage any increase in severity of the risks as a result of further climate change. This may require a significant increase in mitigation investment in the future.

National Grid Gas plc acknowledges that climate adaptation is an evolving science and it is envisaged that the flexible approach that has been adopted will allow for risks to be reassessed as further information becomes available. National Grid Gas plc found the UKCP09 information invaluable in completing its analysis, but has highlighted areas where additional information would be useful in the future particularly around the following Specific Physical Characteristics: Increased lightning, wind and gale, snow, sleet, blizzard, ice and freezing fog and increased subsidence. It would also be helpful for future data to include absolute values or ranges as well as any incremental values from historic trends.

In conclusion, the analysis and results have demonstrated that National Grid Gas plc has a good understanding of the risks of climate adaptation. The management of these risks is already at an advanced stage of being embedded into the normal day to day business risk processes, with appropriate actions being developed and delivered. As a consequence National Grid Gas plc is well placed and in a good state of preparedness as assessed against future anticipated climate change scenarios.

2. INTRODUCTION AND BACKGROUND TO REPORT

This report was produced following a direction to report issued by The Department for Environment, Food and Rural Affairs (Defra) as a result of the Climate Change Act (2008). The UK is the first country in the world to have a legally binding, long-term framework to cut carbon emissions. The Climate Change Act also creates a framework for building the UK's ability to adapt to climate change. Part of the Act requires the Secretary of State to lay before Parliament assessments of the risks posed to the UK by climate change. This is National Grid's response to the Act.

This work is being undertaken within the Adapting to Climate Change (ACC) cross government programme, based in Defra and the first assessments will be laid before Parliament in January 2012 and updated every 5 years.

The ACC programme identified National Grid as being of particular importance in adapting the country to the impacts of climate change, and it is therefore considered within the strategy as a priority reporting authority. In March 2010, National Grid Electricity Transmission Plc and National Grid Gas Plc were issued with the Direction to report which as a legal instrument placed a deadline for the companies to report in September 2010.

National Grid has produced two separate reports and this is the report for National Grid Gas Plc relating to Gas Transmission and Distribution in the UK and has been prepared in accordance with the Statutory Guidance issued by Defra to reporting authorities in 2009.

The first phase of adaptation reporting will lead to the first full round of mandatory reporting by a wide range of industries and agencies in 2011. Other organisations participating in the first phase of reporting are: The Environment Agency, Highways Agency, Network Rail, Natural England, and Trinity House (Lighthouse Authority).

The purpose of this report is to provide details as to how National Grid Gas plc has assessed the specific business risks associated with climate change and demonstrated the steps being taken in adapting to the challenges posed by climatic change.

Section 4.1 of the report provides an overview of how Britain's gas market operates, the role of National Grid Gas plc, other stakeholders and the key assets involved to set the context for the nature and impact of climatic risks to National Grid Gas plc.

Section 4.2 describes the level of adaptation preparedness already in place within National Grid Gas plc and outlines the National Grid approach to risk management.

Section 4.3 defines the methodology applied in assessing the climatic risk to National Grid Gas plc and describes the process employed of adopting a worst case scenario basis to identify the specific assets and processes that require further review.

Section 4.4 provides a summary of the results from the initial assessment and Sections 4.5 and 4.6 discuss the uncertainties, assumptions and actions identified through this review.

The subsequent sections provide an appraisal of the process, opportunities identified through the assessment, recommendations and conclusions to this study.

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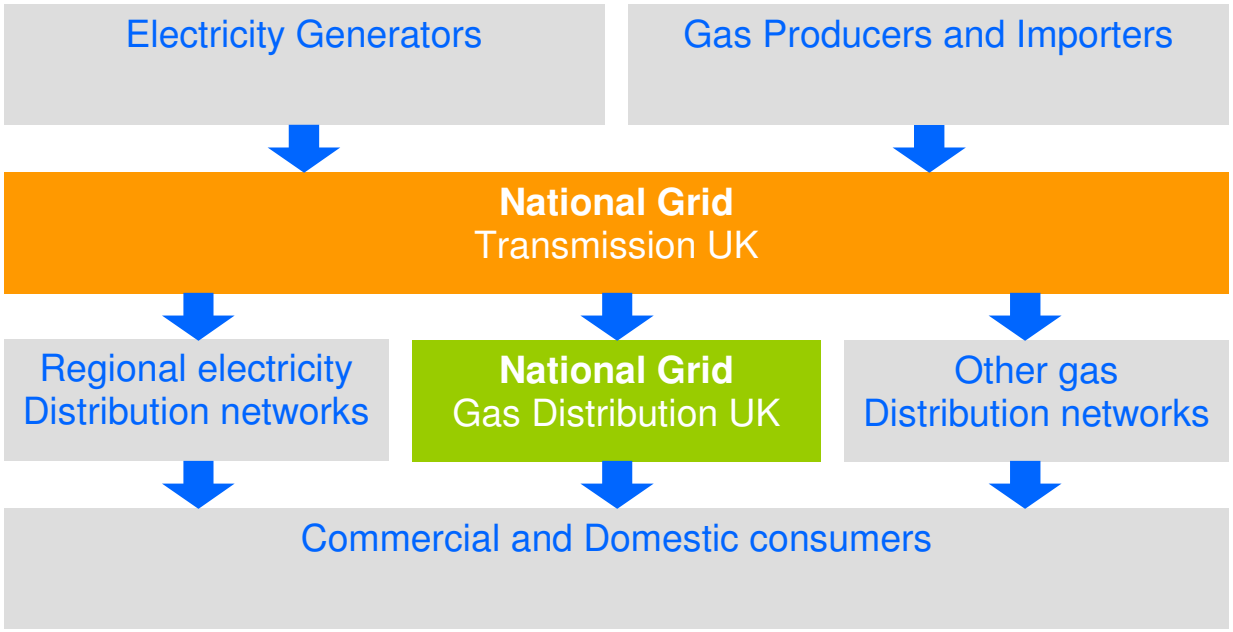
3. OVERVIEW OF NATIONAL GRID

National Grid originated from the restructurings of the UK gas industry in 1986 and the UK electricity industry in 1990. The principal markets in which National Grid operates in the UK are the electricity and gas markets, National Grid owns and operates the high voltage electricity transmission system in England and Wales and the UK Gas Transmission system. As National Electricity Transmission System Operator (NETSO), National Grid also operates the Scottish high voltage transmission system and the offshore transmission system. National Grid owns low pressure gas distribution in the heart of England distributing to approximately eleven million homes, offices and schools. In addition National Grid owns and operates significant electricity and gas assets in New England and New York in the United States.

National Grid as an international electricity and gas company is one of the largest investor-owned energy companies in the world. National Grid plays a vital role in delivering gas and electricity to many millions of people across Great Britain and north-eastern US in an efficient, reliable and safe manner.

Figure 3.1 Energy Transportation in the UK



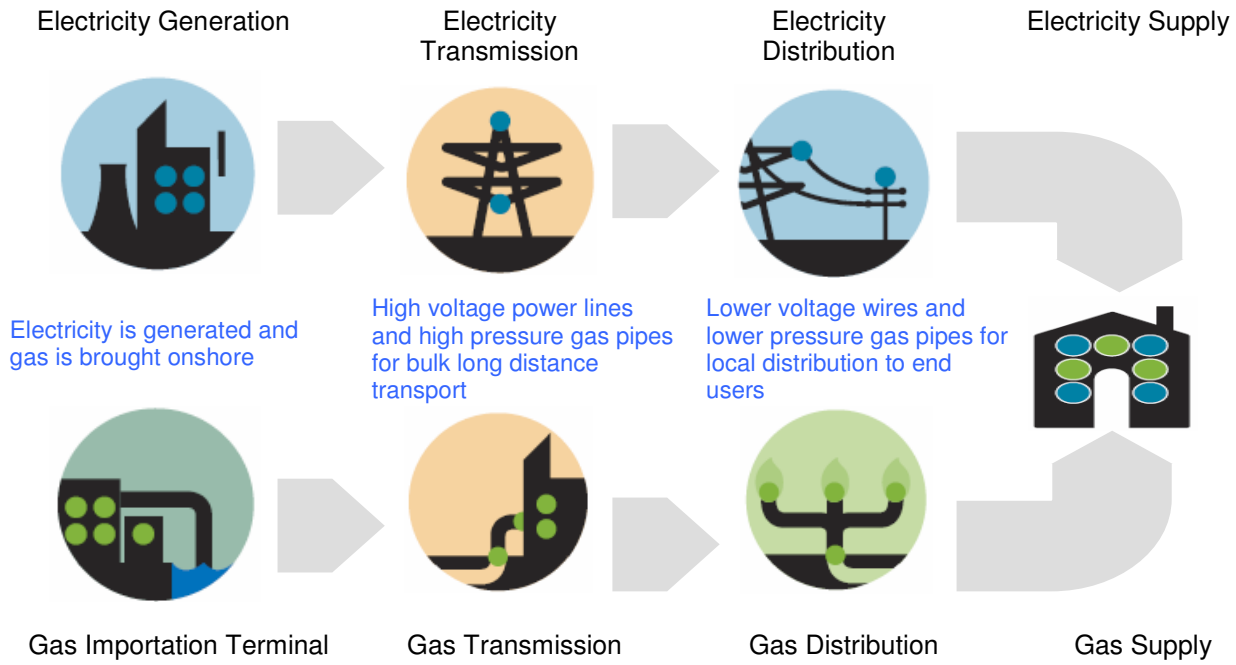
The key roles in the provision of gas and electricity in the UK are shown in Figure 3.1. The supply of electricity and gas in the UK is competitive in that consumers can choose their energy supplier. Those suppliers are then responsible for sourcing the energy from electricity generators or from gas producers or importers as appropriate, as well as arranging for that energy to be delivered through physical delivery networks. These networks, including the ones National Grid operates, are natural monopolies in their local areas because, for the majority of consumers, there are no alternative methods of transporting electricity or gas.

Energy Delivery in the UK

In general in the UK, energy is transported through electricity or gas transmission networks to regional electricity or gas distribution networks that then deliver energy to consumers on behalf of suppliers. This is shown in Figure 3.2. Certain end users, primarily large industrial consumers, receive electricity or gas directly from the relevant transmission network, rather than through a distribution network (not shown in diagram).

National Grid Electricity plc is the owner and operator of the high voltage electricity transmission network in England and Wales; operator, but not owner, of the two electricity transmission networks in Scotland; and owner and operator of the national gas transmission system and of four of the eight regional gas distribution networks in Great Britain. National Grid charges electricity and gas suppliers, electricity generators and gas shippers for its services. There are 14 electricity distribution networks in the UK, owned by 7 different companies.

Figure 3.2 How the Energy Industry Operates



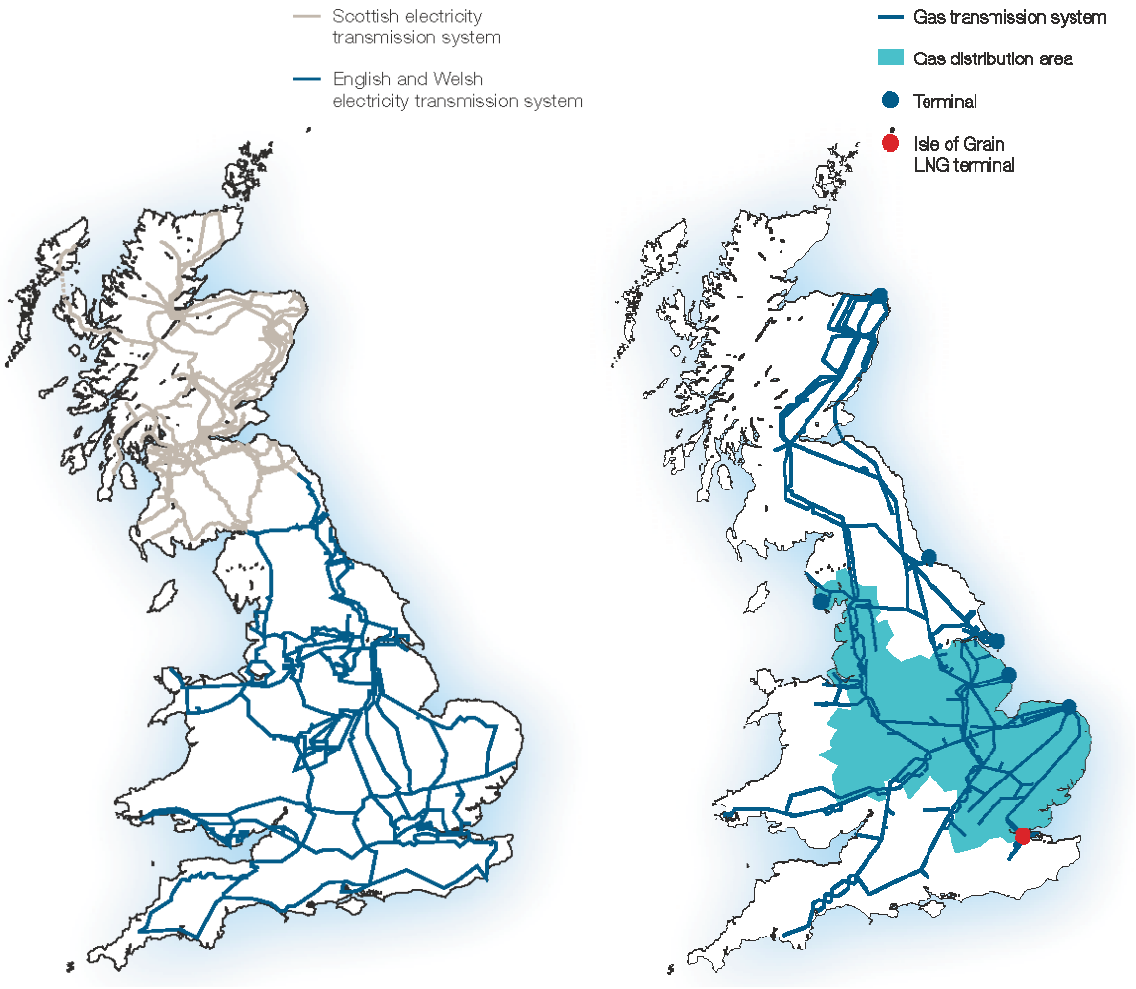
Key Facts

- Over 90% of Britain's gas demand, ~1200Wh/a, flows through National Grid's Gas Transmission System and this figure rises further, closer to 95%, if gas producers own use gas (offshore) is excluded. This is approximately 40% of Great Britain's primary energy demand (including transport)
- Great Britain is covered by 8 gas distribution networks that deliver over 60% of residual energy demand to over 22m consumers (80% of Great Britain's total properties). National Grid owns and operates 4 of the 8 networks covering the North West, Midlands, East Anglia and London and approximately half of the gas consumers nationwide.
- Approximately 90% of electricity demand is transmitted across National Grid's Electricity Transmission system. The equivalent of 13% of the UK's primary energy demand (including transport) is transmitted across National Grid's Electricity Transmission System.

In the UK, National Grid's businesses primary duties under the Electricity and Gas Acts are to develop and maintain efficient and reliable networks and facilitate competition.

Through National Grid's subsidiaries, National Grid also owns and maintains around 18 million domestic and commercial meters, the electricity inter-connector between England and France, and a Liquefied Natural Gas importation terminal at the Isle of Grain. Figure 3.3 shows the key elements of the gas and electricity networks in the UK.

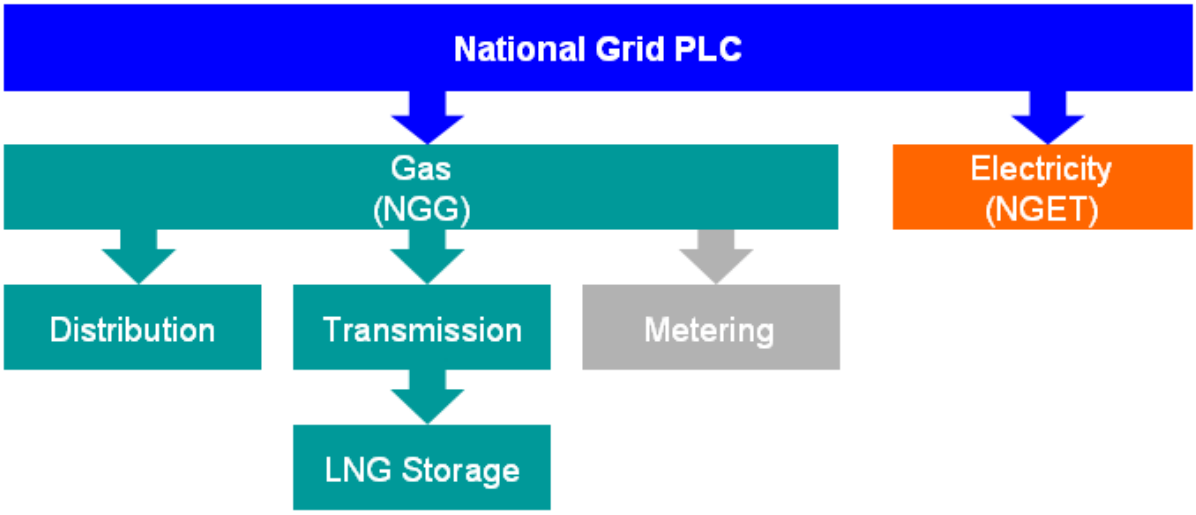
Figure 3.3 Electricity and Gas Networks



National Grid's core activities are natural monopolies and accordingly are regulated businesses. Regulated utilities operate under a Licence that governs the service levels.

Figure 3.4 illustrates National Grid's business units and identifies those business units by UK Licence covered within the National Grid Electricity Transmission plc's (NGET) Licence and the National Grid Gas plc's (NGG) Licence.

Figure 3.4: National Grid Structure and Adaptation Assessment Coverage



It is noted that certain business units within National Grid have been excluded either because they are not covered by the regulatory Licence or have been excluded due to the negligible level of impact expected as a result of climate change (e.g. National Grid Metering where its assets are located within customer's homes/properties and Isle of Grain as an unregulated storage business).

National Grid's Vision

> ***"We, at National Grid, will be the foremost international Electricity and Gas Company, delivering unparalleled safety, reliability and efficiency, vital to the wellbeing of our customers and communities.***
>
> ***We are committed to being an innovative leader in energy management and to safeguarding our global environment for future generations."***

From the National Grid vision "delivering unparalleled reliability to the wellbeing of our customers and communities" effectively means that National Grid's networks are designed, maintained and operated to ensure efficient and resilient performance for the UK consumer, considering the effects of climate change and other factors.

This report details the adaptation assessment for National Grid Gas plc.

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4. RESPONSE TO STATUTORY GUIDANCE

4.1. INFORMATION ON ORGANISATION

National Grid Gas plc Transmission and Distribution

National Grid Gas plc owns and operates the gas transmission system throughout Great Britain which consists of approximately 6,800 km of high pressure transmission pipelines and owns and operates almost half of the low pressure gas distribution network consisting of over 130,000 km of distribution pipelines, distributing gas in the heart of England to approximately eleven million homes, offices and schools. Also operated as part of the transmission system are three Liquefied Natural Gas Storage facilities in Bristol, Manchester and Glasgow.

In the UK, National Grid Gas plc's primary duty under the Gas Act is to develop and maintain efficient networks and under the Licence to facilitate competition in the supply of gas. National Grid Gas plc's activities include the residual balancing in close to real time of the gas market.

National Grid Gas plc is committed to piping gas in the safest and most efficient way to homes and businesses.

In March 1996, the Network Code came into effect which comprised a legal and contractual framework for the supply and transportation of gas. In 2005 as a result of the sale of four of the gas distribution networks, the Network Code was replaced by the Uniform Network Code (UNC) which is currently administered by the Joint Office of Gas Transporters and provides a common set of rules for all industry players which ensure that competition can be facilitated on level terms. National Grid Gas plc complies with UNC.

National Grid Gas plc does not sell gas. The gas supplied to homes or businesses is supplied to by a Gas Supplier. Only suppliers licensed by Ofgem (Office of Gas and Electricity Markets - see www.ofgem.gov.uk) can sell gas. Figure 4.1.1 overleaf shows the process by which gas is bought, sold, transported and delivered to consumers in the UK. It details the roles played by various parties involved in this process.

Figure 4.1.1 Gas market roles

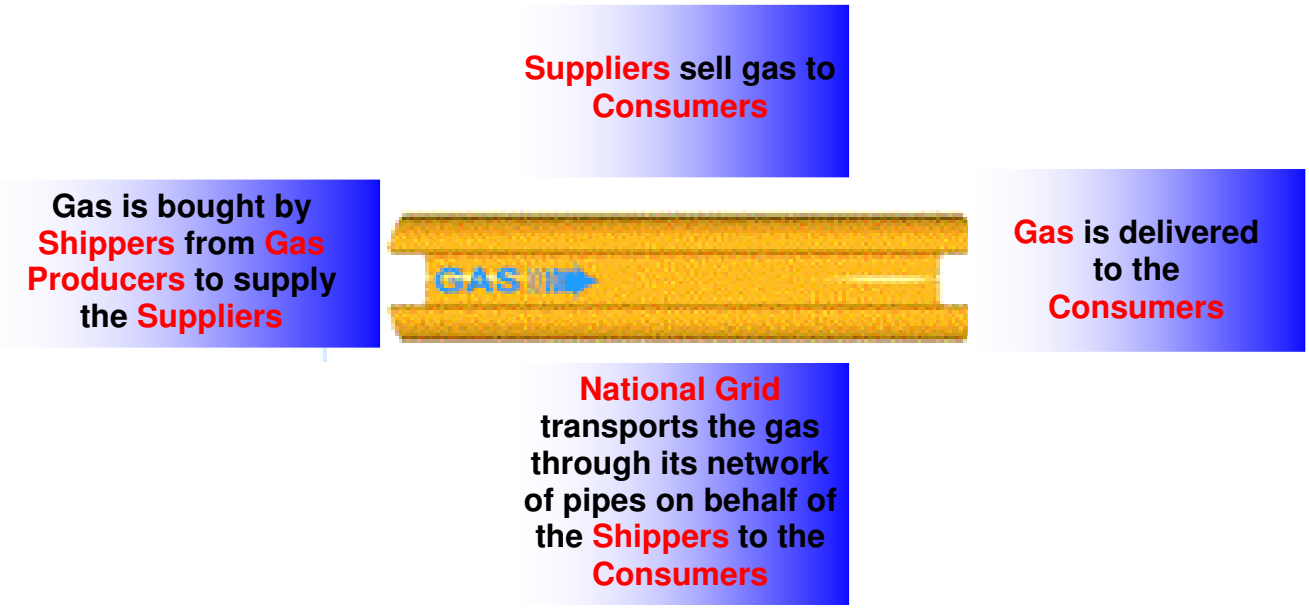
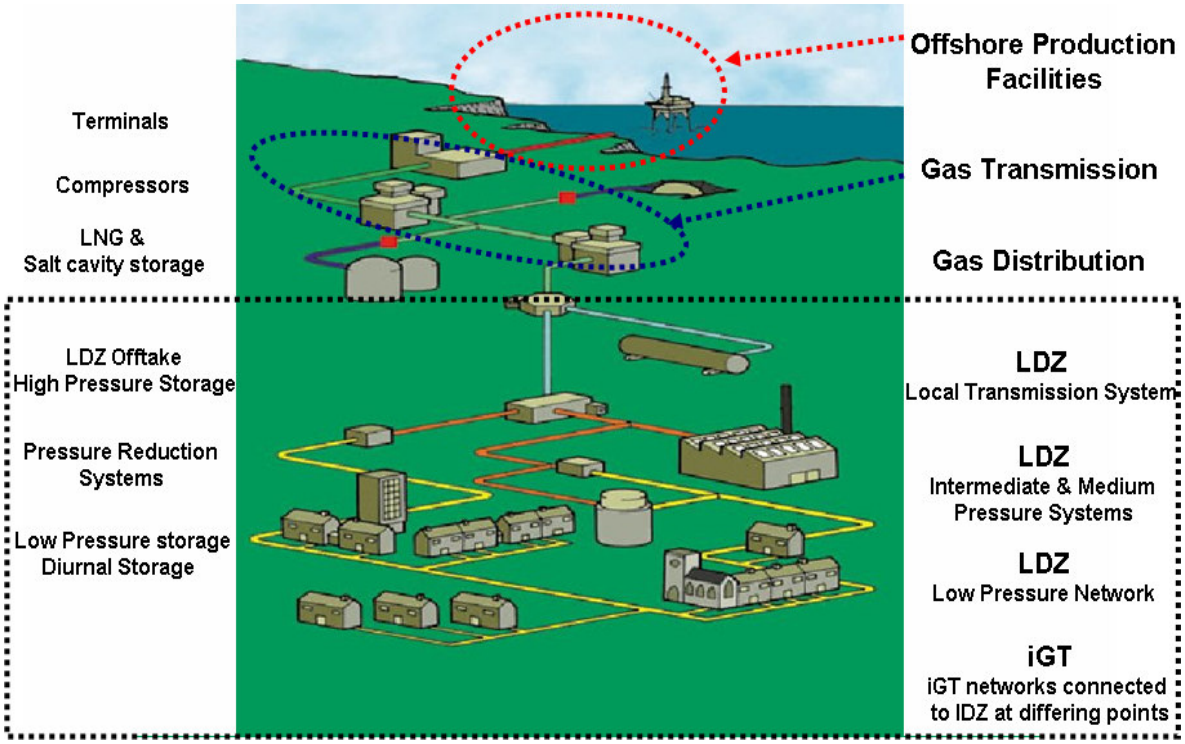


Figure 4.1.2 Gas Transportation Process – Offshore to Domestic Users



Gas is produced offshore and brought to the beach by gas processing companies, the gas is processed (unwanted components are removed) and passed to a National Grid Gas plc terminal which is the start of the National Grid Gas plc network.

Seven terminals receive gas processed by gas processing companies, ensure the received gas is within specification and then feed it to the National Transmission System (NTS).

The NTS operates at high pressure (70 to 94 barg). The pressure is maintained by 26 compressor stations which ensure that gas from the coastally located terminals is available at the point of demand.

Supplementing the gas that is brought into the NTS is gas that has been previously liquefied and stored in one of three Liquefied Natural Gas (LNG) Storage Facilities. This gas can be vaporised and re-injected into the NTS when demand for gas is high.

There are a number of Above Ground Installations (AGIs) which help manage the flow of gas around the transmission system, these include isolation valves, junctions and offtakes.

Gas leaves the NTS through the offtakes, either to large industrial users such as power stations or to the distribution system. The offtakes onto the distribution system supply Pressure Reduction Installations (PRIs), which reduce the pressure from NTS pressure.

The distribution system is made up of over 130,000 km of pipework split between the local transmission system (LTS) and intermediate, medium and low pressure systems (IP, MP and LP respectively). 99 % of the gas that enters the NTS passes into the LTS. Of this gas, around 1% is consumed, with the remainder passing to the IP system (40 %) and the MP system (60 %).

Around 80% of the gas that comes on shore into the NTS is delivered to the end user through the LP system. This accounts for 99 % of National Grid Gas plc's customers.

Figure 4.1.2 illustrates the elements of the gas transportation process and how gas is transported to Local Distribution Zones (LDZs).

4.2. BUSINESS PREPAREDNESS

Business Preparedness before the Direction to Report was Issued

National Grid has put climate change at the heart of its business. Alongside adapting its networks to climate change, National Grid is committed to both reducing its impact and helping the UK's transition to a low carbon economy. For example:

1. Embedding a **target of 80% greenhouse gas reduction** across its businesses by at least 2050 with a mid term reduction target of 45% by 2020.
2. **Investing in its infrastructure** over the next five years to connect new low carbon energy sources..
3. **Encouraging businesses, organisations and individuals** to meet the climate change challenge and embrace energy efficiency.

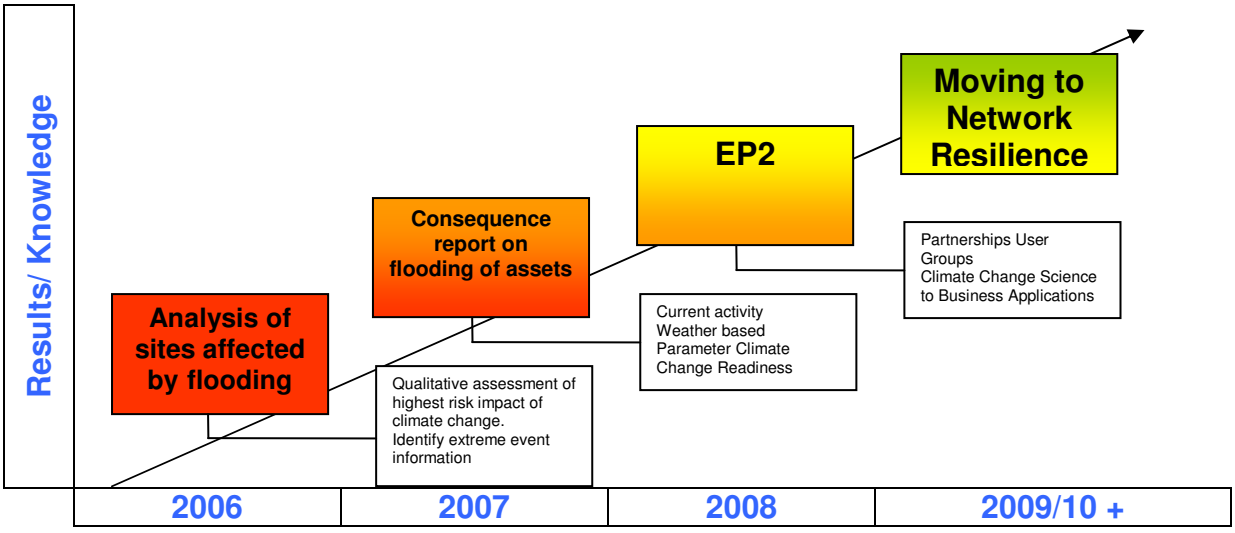
Asset management principles are embedded into all of National Grid's businesses including Electricity Transmission, Gas Transmission and Gas Distribution. This is demonstrated through its PAS55 certification which is a publicly available specification for the optimized management of physical assets. As part of its day-to-day business National Grid Gas plc regularly assesses risks to its assets including the risk from climate change.

National Grid has worked alongside the Climate Scientists at the Met Office, Hadley Research Centre and other energy companies over the last 3-4 years on research to better understand and prepare for the wider impacts of climate change on its electricity and gas assets and business operations.

In addition, National Grid Gas plc has worked closely with the Environment Agency since 2006 in addressing flood risks and sharing our work on the risk to gas sites currently within flood zones as indicated on the Environment Agency flood maps. This work is under continuous review as more data becomes available.

National Grid Gas plc's has been engaged in a number of initiatives related to climate change impacts and the journey so far has been summarised in Figure 4.2.1.

Figure 4.2.1 National Grid Gas plc's engagement with climate change initiatives



Regulation and Levels of Service

The following key documents address important areas of regulation and levels of service for the gas transmission and distributions systems:

Gas Safety (Management) Regulations (1996)
The GS(M)R, which are part of health and safety legislation, set the legal parameters for gas entering into and leaving the GB gas network. These parameters are set to ensure the safe distribution and utilisation of gas. All gas entering the National Transmission System (NTS) at either sub-terminals or in some cases specified downstream blending points must comply with these regulations.

Control of Major Accident Hazards Regulations (1999) and Control of Major Accident Hazards (Amendment) Regulations (2005)
The aim of the Control of Major Accident Hazards Regulations 1999 (COMAH) and the Control of Major Accident Hazards (Amendment) Regulations 2005 is to prevent and mitigate the effects on people and the environment of those major incidents involving dangerous substances. COMAH applies mainly to the chemical industry, but also to some storage activities, explosives and nuclear sites, and other industries where threshold quantities of dangerous substances identified in the Regulations are kept or used.

Pipeline Safety Regulations (1996)
The 1996 PSR Regulations provide for the management of pipeline safety and apply to all pipelines in Great Britain and to all pipelines in UK territorial waters and on the UK Continental Shelf.

Gas Transporters License
National Grid Gas plc holds a gas transporter licence granted by the Gas and Electricity Markets Authority under the Gas Act 1986 in respect of the NTS and each of its distribution networks. This licence set out the regulatory conditions which must be met by the regulated business, including levels of service, funding mechanisms, investment and operating obligations.

Unified Network Code
The Uniform Network Code (UNC) is the hub around which the competitive gas industry revolves, comprising a legal and contractual framework to supply and transport gas. It has a common set of rules for all industry players, which ensure that competition can be facilitated on level terms. It governs processes, such as the balancing of the gas system, network planning, and the allocation of network capacity.

Design Standards

National Grid Gas plc's gas network infrastructure is designed to national and international industry standards. As these international standards apply within Europe and across the world in countries where existing conditions are similar to those projected due to climate change for the UK by 2080, it demonstrates a degree of existing resilience to the expected climate changes.

Equipment in the UK is based on industry standards that have been developed and enhanced over many years to ensure that UK networks are built from high specification, safe equipment that is fully interchangeable and can be installed and operated in a similar manner across the UK.

These industry standards and engineering practices have been established over the years through the various organisations such as the Institution of Gas Engineers and Managers (IGEM) and hence having been designed and built on a common basis; they will all experience similar impacts from changes in the climate. This underlines the reason for a common approach to national issues in adaptation.

The production of new documents and the updating of existing documents is covered by an agreed process involving all relevant transmission and distribution network operators. Further details on these standards can be found in Appendix B.

Embedding Climate Change Risk Assessment into the Organisation

The assessment of climate change risk is embedded into the National Grid organisation via the risk and compliance process, as detailed in Section 4.3 and ultimately results in actions or changes in policies and procedures where required. National Grid has processes in place to monitor legislation changes and changes to industry policy and procedures such that the policies and procedures within National Grid are reviewed and updated as necessary to remain current with regard to published information.

National Grid's attitude to risk management helps focus attention on business critical activities to bring increased consistency to all operations. In this way, where a risk is common to all National Grid's operations, such as climate change, the Corporate Centre sets out the strategy to respond to the risk while the business units tailor the guidance to meet their operational requirements.

National Grid's Group Procedure on Risk Management was approved in 2003 and takes into account the key statutory and best practice outcomes including:

- Combined code 2003, in particular the related Turnbull Guidance on Internal Control
- US Corporate and Criminal Fraud and Accountability Act of 2002 (the Sarbanes-Oxley Act)
- Risk Management Standard produced in 2002 by UK professional bodies, e.g. Institute of Risk Management

The group procedure is aimed at ensuring a consistent 'best practice' approach is adopted across National Grid to identify and manage risks to ensure that:-

- Risks are considered in the context of their ability to impact the business objectives
- Clear allocation of responsibilities for managing risk
- Proactive review of risks (on management and executive agendas)
- Supporting systems are in place to assist in the effective management of risks.

National Grid's Risk and Compliance Process

National Grid has a robust risk and compliance process which has already identified and included climate adaptation risks for assessment. Best practice risk assessment should:

- Focus on those risks that would impact upon your business objectives
- Rely on professional judgement and common-sense
- Be relevant to business area
- Focus on significant current and future events
- Consider historical information and experience where available
- Identify the causes and consequences of each risk
- Highlight the impact of the risk (both financial and reputation) and the likelihood (probability or frequency) of its occurrence
- Identify the controls in place or that are needed, to remove or reduce risks to a target level

The Risk Management Control Procedure sets out that, as minimum, key risks are reviewed at National Grid Executive level on a half-yearly basis.

Key risks are reviewed by the National Grid Gas plc Directorate Management Team at least on a quarterly basis and in line with Group procedure requirements. This review focuses on changes in risk profile throughout the period and progress to date against actions.

If the risk(s) is not mitigated to the target level assessed for the risk, actions are required to be completed in order to manage the risk to an acceptable target level. In this instance, the review should focus on improvement actions needed to achieve the target rating.

An example of this process in practice is the risk of sites flooding which brought about an action to assess the location of sites against the probability and impact of a flood occurrence. Further information on National Grid's Risk and Compliance Process can be found in section 4.3.

Recent examples of actions that National Grid Gas has taken as a consequence of climate adaptation related risks include:

- In 09/10 National Grid Gas plc had to reinforce a river bank as a result of the bank being eroded close to a high pressure pipeline
- In 09/10 National Grid Gas plc instigated an R&D programme looking at the impact of flooding on its pipelines and pressure reduction equipment

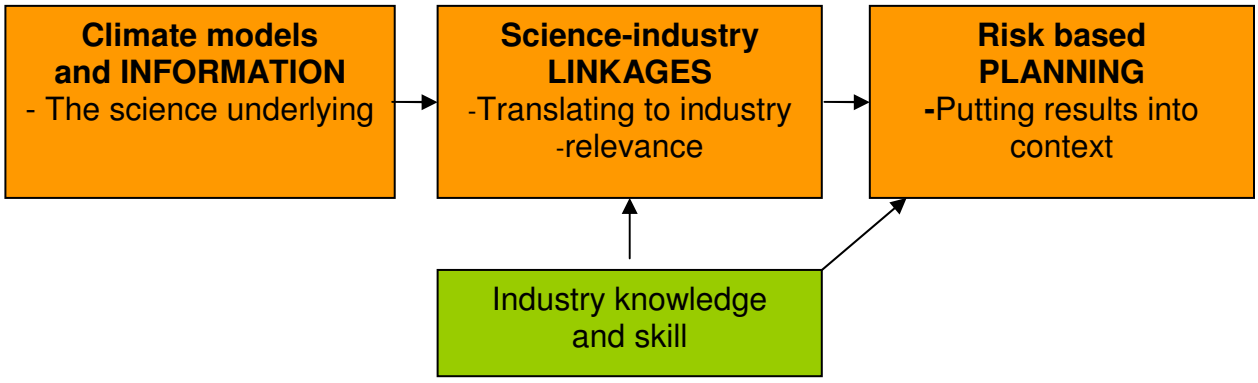
Investigative Studies on the Impacts of Climate Change

Met Office Project EP2

In 2008, alongside other energy companies and the Met Office, National completed a groundbreaking study to consider the effects of climate change on the energy industry.

The 14-month project called 'Energy Project 2 (EP2) set out to establish what effect climate change will have on the industry's infrastructure and business. EP2 project was carried out with industry experts (working in partnership, see the diagram below) with the view to bring the science very close to practical business application for planning purposes.

Figure 4.2.2 Partnership approach



EP2 was vital for the industry because of the need to be able to forecast 15 to 40 years ahead for any current asset investment. The EP2 project has given Energy Industry some of the tools National Grid need for future planning. Energy infrastructure is costly and can have a lifespan of 40 or more years, therefore the Energy Industry took the expert advice of the Met Office Hadley Centre. This will help anticipate the potential impacts of climate change and allow the industry to future proof what it builds in the coming years.

EP2 investigated a number of issues including soil conditions and their impact on cables; how urban heat islands might change so the distribution industry can plan city infrastructure; the relationship between electricity network resilience and weather; a tool to predict sea surges at sites of interest, and climate models and wind projections.

Potential changes in demand are another key factor. The findings of the next 10 years climate data is being considered by Energy Companies to use in their future Energy supply / demand planning process.

The project covered the following areas:

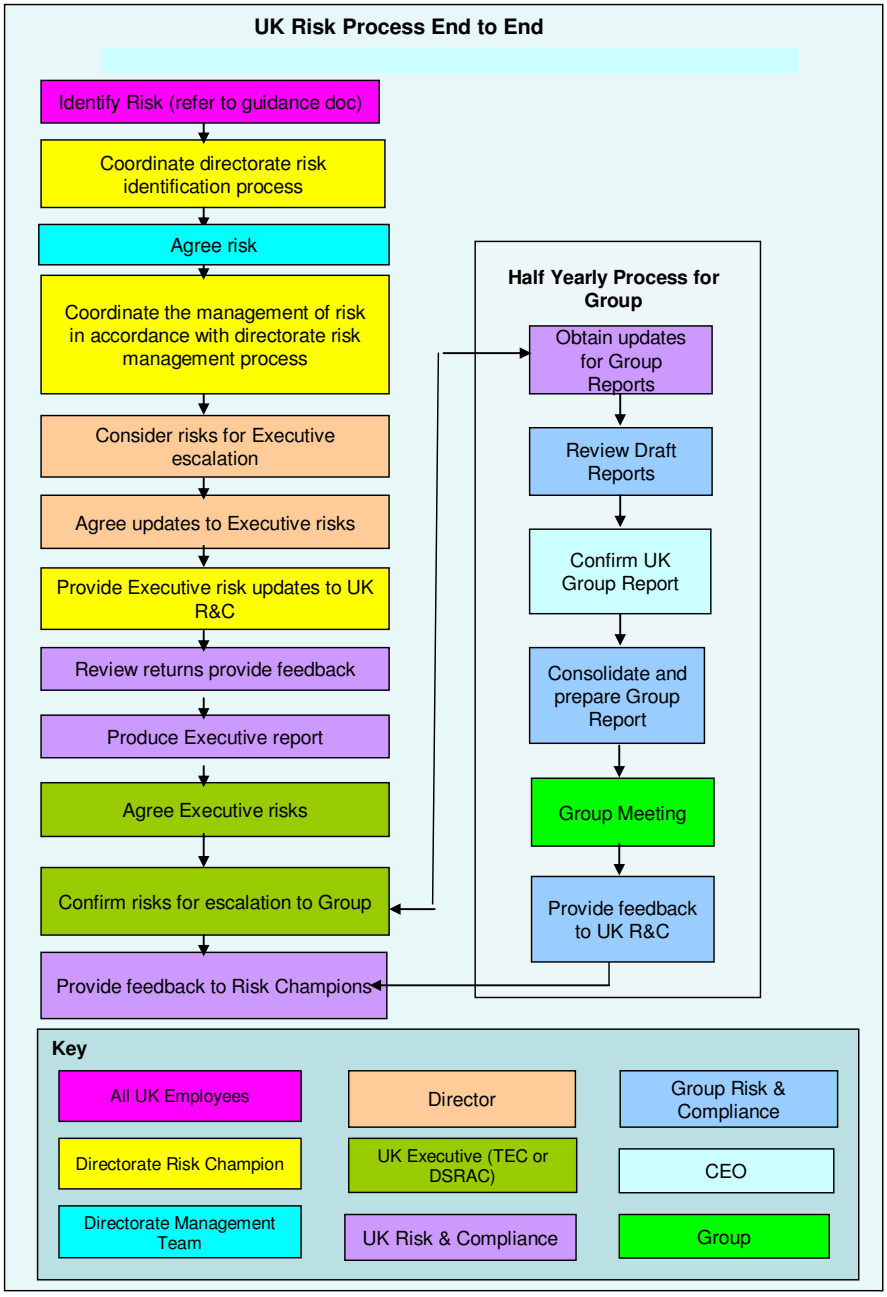
- Developed innovative new techniques that apply climate models to energy applications so that the industry is better placed to adapt to climate change.
- Investigated future wind resource, enabling the industry to understand the continued uncertainty of future wind power. This will assist risk management and investment decisions.
- Modelled future soil conditions and their impact on cables so that Companies can understand the cost and benefits of installing cables for a more resilient future network.
- Built a tool to enable UK and marine sites of interest to be screened to assess if sea level rise should be considered in more detail.
- Investigated how the urban heat island effect may change in the future so that Networks can develop plans for their infrastructure in cities.
- Produced guidance to help make best use of public domain information on climate change such as the United Kingdom Climate Impacts Programme new scenarios of climate change (UKCP09).
- Delivered new site specific climatology's of temperature, wind speed and solar radiation that account for climate change so that decisions can be based on realistic climate expectations.
- Examined the relationship between historic weather patterns and network fault performance with a view to developing a tool to predict future network resilience.

4.3. IDENTIFYING THE RISKS DUE TO CLIMATE CHANGE

Risk Assessment Methodology

National Grid's approach to assessing the risks has been consistent across both Electricity and Gas and the details of the process can be found in Figure 4.3.1. As part of ongoing risk processes, climate change issues have been captured and follow through to the annual report and the Corporate Responsibility report.

Figure 4.3.1 National Grid's Risk and Compliance Process



Climate Change Risk Assessment Methodology

Figure 4.3.2 Climate Change Risk Assessment Methodology

At present the best available published information on climate change predictions is contained in the UK Climate Projections 2009 (UKCP09) published in July 2009. Figure 4.3.2 shows National Grid's climate change risk assessment methodology.

UKCP09 provides historic and projected climate information for the UK up to the end of this century. Projections of the future changes to the UK's climate are provided, based on simulations from climate models.

The projections show three different scenarios representing high, medium and low greenhouse gas levels. The types of climate information provided are:

- Observed climate data (20th and 21st century historic information about temperature, precipitation, storms, sea surface temperatures and sea level)
- Future climate projections (for temperature, precipitation, air pressure, cloud and humidity)
- Future marine and coastal projections (for sea level rise, storm surge, sea surface and sub-surface temperature, salinity, currents and waves)

Key vulnerabilities in the energy sector are those associated with higher temperatures and an increase in intensity of precipitation. Other possible vulnerabilities may include changes in wind and the increased frequency of lightening etc. To date there is no published data in UKCP09 to support any increases in these areas.

In summary, using the UKCP09 work, three scenarios were developed for 2020, 2050 and 2080. National Grid has chosen to risk assess its assets and processes against the high level scenario which is based on the least likely to occur prediction of climate change as of 2080. This was on the basis that should National Grid's assets and process demonstrate resilience against this scenario it would inevitably be adapted against lower and more likely climate change. This is also consistent with general planning assumptions within the businesses.

To better understand the potential impacts and associated risks that these Climate Change Scenarios pose on National Grid Gas plc's assets they have been converted into key 'Specific Physical Characteristics'. To help do this additional information has been taken from the Met Office's work on climate risk assessment on future network resilience and combined with National Grid Gas plc's engineering judgement.

The result has been to identify Specific Physical Characteristics that are likely to be caused by these scenarios, and it is the impact of these characteristics to National Grid Gas plc's key assets and processes that is risk assessed. The Physical Characteristics can be broken down into three groups that provide a total of nine Specific Physical Characteristics:

1. **UKCP09 Characteristics** are directly correlated to the UKCP09 work and so have greater definition and probabilities around them

2. **Met Office Characteristics** are taken from the Met Office work on "Risk Assessment on future Network Resilience"

3. **National Grid Characteristics** added by National Grid to ensure that the main key risk areas are covered

For the final two groups, although these characteristics may be caused as a result of climate change, further work will be required in the next update of the UKCP09 data to assess any expected increases in magnitude and the associated probabilities.

The Specific Physical Characteristics can be summarised as follows:

UKCP09 Characteristics

- Summer mean temperature rise of up to 8 ℃
- Increased heavy rainfall (by a factor of up to 3.5)
- Sea level rises of up to 43 cm

Met Office Characteristics

- Increased lightning
- Increased Wind and gale
- Increased Snow, sleet, blizzard, ice and freezing fog
- Increased flooding

National Grid Characteristics

- Increased coastal/river erosion
- Increased subsidence

Having identified the Specific Physical Characteristics, the key asset types to assess these against were identified starting with the PAS55 asset types. For National Grid Gas plc Transmission these were:

- The National Transmission System (NTS) (70 - 94 barg system)
- NTS river crossings
- Gas Terminals
- Compressor Stations
- Liquefied Natural Gas (LNG) Storage Facilities
- Above Ground Installations (AGIs)

These assets are critical to delivering National Grid Gas plc Transmission's business objectives. NTS river crossings have been identified as a separate asset as they are subject to a number of different environmental factors than the rest of the NTS. By separating them from the rest of the NTS, a more robust risk assessment could be completed for both asset types.

For National Grid Gas plc Distribution, the following assets were identified:

- The Local Transmission Systems (above 7barg system);
- The Distribution System;
- Pressure Reduction Installations (PRIs)
- Control Systems and Telemetry

Gas holders have not been included as part of the assessment as they are currently all within a decommissioning strategy and hence are all scheduled to be removed from the network during the risk assessment period. Should any of them become inoperable in the short term, National Grid Gas plc Distribution has planned contingencies that would protect the supply of gas to consumers.

As well as the impact on assets, it was identified that changes in climate may affect how National Grid Gas plc operates its assets and so the key business processes that support the installation, operation and maintenance of these assets as well as protecting public safety were included.

- Emergency
- Maintenance
- Investment and Repair
- Control Centre Operations
- Office staff (including contact centres)

The Adaptation Risk Assessment process applies the Specific Physical Characteristic, one at a time, to each of the Key Assets and Processes. It then assesses if the result may have an impact on the public from a security of supply perspective albeit there maybe other impacts.

This analysis has four potential outcomes that are identified using the following approach:

Green No material risk to assets or processes from the Specific Physical Characteristic. This is either because no risk has been identified or the existing assets or processes are robust and no further action is required in terms of adaptation measures.

Yellow A level of risk has been identified through the risk assessment. Action plans have or are being developed and progress is being monitored via the risk process, it may be that additional investment will be required to manage these risks. These risks have been further assessed using National Grid's risk management process.

Amber Insufficient information is currently available on the affects of the Specific Physical Characteristic to calculate the level of risk. Further monitoring or assessment will be carried out to better understand this risk.

Red Highly likely or significant, material risk in the future. Current business processes and action plans do not adequately address this specific risk. Full risk assessment and action plan to be developed.

The outcome of this process can be seen in section 4.4 with the detailed process included in Appendix D.

National Grid Gas plc has embedded in its processes the costs of adaptation, for example flooding is on the risk register, and the associated schemes to mitigate this issue are produced and sanctioned within existing processes. A cost benefit analysis for each individual scheme is required as part of National Grid's scheme sanction process.

4.4. ASSESSING RISKS

Adaptation Risk Assessment Results

Whilst it is apparent that energy infrastructure may be vulnerable to certain aspects of climate change, the infrastructure has a significant degree of resilience, to change and therefore adaptation. In addition, technically it will be feasible to deal with adaptation issues over short, medium and long-term periods. Energy infrastructure is designed to international standards and the same standards allow infrastructure to operate around the world in varying climatic conditions, including projected climate conditions for the UK.

The identified Specific Physical Characteristics which National Grid Gas plc has risk assessed against our main assets and processes are:

- Summer mean temperature rise of up to 8 ℃
- Increased heavy rainfall (by a factor of up to 3.5)
- Sea level rises of up to 43cm
- Increased lightning
- Increased Wind and gale
- Increased Snow, sleet, blizzard, ice and freezing fog
- Increased flooding
- Increased coastal/river erosion
- Increased subsidence

Table 4.4.1 shows a summary of the process described in Section 4.3 for National Grid Gas plc Transmission. A detailed version of this assessment can be found in Appendix E.1

Table 4.4.1 Specific Physical Characteristics of Climate Adaptation Scenarios for National Grid Gas Transmission

	Specific Physical Characteristics of Climate Adaptation Scenarios								
	UKCP09 Characteristics			Met Office Characteristics				NG Characteristics	
Key Assets and Processes	Solar Heat - Temperature rise of up to 8C	Increased Heavy Rainfall (by a factor of 3.5)	Sea Level Rises of up to 43cm	Lightning	Wind and Gale	Snow, Sleet, Blizzard, Ice and freezing fog	Flooding	Coastal/river erosion	Subsidence
Included in National Grid Risk Management Process	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Assets									
National Transmission Pipe work (~ 70 barg system)									
River Crossing									
Compressor Station									
LNG Storage Facilities									
Above Ground Installations									
Gas Terminals									
Processes									
Emergency									
Maintenance, Construction & Fault Repairs									
Investment, Construction and Repairs									
Control Centre Operations									
Office Staff (including call centre)									

Table 4.4.2 shows a summary of the process described in Section 4.3 for National Grid Gas plc Distribution.

Table 4.4.2 Specific Physical Characteristics of Climate Adaptation Scenarios for National Grid Gas plc Distribution

	Specific Physical Characteristics of Climate Adaptation Scenarios								
	UKCP09 Characteristics			Met Office Characteristics				NG Characteristics	
Key Assets and Processes	Solar Heat - Temperature rise of up to 8°C	Increased Heavy Rainfall (by a factor of 3.5)	Sea Level Rises of up to 43cm	Lightning	Wind and Gale	Snow, Sleet, Blizzard, Ice and freezing fog	Flooding	Coastal/river erosion	Subsidence
Included in National Grid Risk Management Process	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Assets									
Local Transmission Systems (above 7 barg)									
The Distribution System (below 7 barg)									
Pressure reduction Installations (PRI's)									
Control Systems and Telemetry									
Processes									
Emergency									
Maintenance, Construction & Fault Repairs									
Investment, Construction and Repairs									
Control Centre Operations									
Office Staff (including call centre)									

4.5. UNCERTANTIES & ASSUMPTIONS

Uncertainties in the Adaptation Programme

National Grid Gas plc's adaptation plans are based on the evidence provided by UKCP09 and this information covers three scenarios for future climate change which are projections.

As the current data from the UKCP09 work is specific to temperature, rainfall and sea level rises, National Grid Gas plc developed additional characteristics using data from work that it had completed with the Met Office and engineering judgement to give a wider range of scenarios.

As there is less detail available for these new characteristics they were treated more generically and so were not assessed to the same level as the UKCP09 Characteristics which were very specific. However, it was felt valuable to make broad assumptions around the potential impact on National Grid Gas plc's assets if these characteristics materialise.

Climate change thresholds that start to trigger extreme weather events such as flooding or storms could be critical for National Grid Gas plc. Experience indicates these events may cause disruption to society while repairs are undertaken.

At present UKCP09 does not provide any specific guidance on the potential effects of climate change on the Met Office and National Grid's additional characteristics, refer to Section 4.3.

National Grid will continue to maintain close contact with the Met Office and other agencies to ensure that the most up to date information is available regarding these potential threats.

Information Gap Analysis / Recommendations

National Grid Gas plc welcomes any further information or assistance from the Met Office or other such agencies to enable us to better asses the risks going forward. Specifically the following limitations have been identified in available information within UKCP09 data:

- There is no information on future changes in frequency / intensity of wind / gales,
- There is no information on future changes in the frequency / intensity of lightning
- There is no information on future changes in frequency / intensity of snow, sleet, blizzard, ice and freezing fog
- Environment Agency Shoreline Management plan review (Coastal erosion) is not expected to be published until 2011

Although these characteristics may be caused as a result of climate change, further work will be required in the next update of the UKCP09 data to assess any expected increases in magnitude and the associated probabilities.

National Grid Gas plc will also welcome any further research into the impacts of climate change on soil stability and subsidence, particularly with regard to its cast iron pipework which is considered to be more vulnerable than pipework made from other materials, e.g. steel and polyethylene.

Assumptions

There are a number of fundamental assumptions that underpin National Grid Gas plc's risk assessment. These are detailed below:

1. UKCP09 and data from the Met Office is an accurate representation of climate change that will occur

2. National Grid Gas plc's current business plans are assumed to be acceptable to the Regulators and attract appropriate funding with government regulation continuing to operate without major change.

3. Energy infrastructure continues to operate fundamentally in the same way as it does today.

4. Third party organisations, whose business affects energy infrastructure resilience, continue to operate fundamentally in the same way as they do today.

5. Customers and suppliers requirements for gas will continue to develop in line with National Grid's predicted modelling.

6. There will be no extreme changes to population numbers or distribution profile across the country.

7. There will be no fundamental changes to industry standards or asset knowledge.

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4.6. ADDRESSING CURRENT AND FUTURE RISKS DUE TO CLIMATE CHANGE

Assessing the results that can be seen in Tables 4.4.1 and 4.4.2 it can be seen that there are already a significant number of green cells showing that there are lots of areas where no material risks have been identified. Crucially, there are no red cells, meaning that there are no instances where if the risk were to materialise, there would be an impact to the process in terms of loss of supply, safety or the environment. There are a number of ambers showing that there are gaps in knowledge and understanding and that further work is required. The yellow risks are summarised for both Gas Transmission and Distribution in the tables below.

Table 4.6.1: Summary of yellow risks from Risk Assessment Matrix for Gas Transmission and Distribution

Business Function	Climate variable (e.g. increase in temperature)	Primary impact of climate change variable (e.g. health)	Threshold(s) above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Potential impacts on organisation and stakeholders	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action is planned
Gas Transmission (Pipelines)	Increased Coastal/River Erosion	Potential gas release and security of supply issue due to damaged pipework caused by loss of protection from ground cover.	These points are monitored and controlled regularly. For climate change to have a major effect on the organisation, coastal and river erosion would have to significantly increase above already experienced levels.	There is limited research in river erosion; however the threshold at which we would be affected is seen as relatively high,	If there were no controls in place, this has the potential to lead to security of supply issues.	New river crossings are assessed on the best available technique involving tunnelling and/or direct drilling as opposed to trenching, which has been more susceptibility to river erosion. As present policy, all river crossings are monitored and assessed. Action plan in place on all crossings affected by river erosion	It is thought unlikely that the increased effect of river erosion will cause National Grid Gas plc any significant issue above that already being experienced. However, there is an action plan in place to resolve all outstanding river crossing erosion issues. It is thought that this number will increase in the future, however the processes already embedded in the organisation are seen as able to address this risk.

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Business Function	Climate variable (e.g. increase in temperature)	Primary impact of climate change variable (e.g. health)	Threshold(s) above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Potential impacts on organisation and stakeholders	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action is planned
Gas Transmission (Terminals)	Increased Coastal/River Erosion	Loss of supply due to loss of Gas Terminal.	Loss of Gas Terminal into the sea due to coastal erosion.	This is highly unlikely. The EA monitor the coastal advance and accretion and put a management plan in place to ensure it does not affect the critical national infrastructure.	If there were no controls, the UK would lose gas supplies from the North Sea and or Europe. This would be a major security of supply issue.	Work with the EA to ensure coastal management plans are up to date and effective. Need to ensure that there is a suitable plan in place for the Scottish gas terminal.	With continuation of shoreline management plans, it is believed that this is highly unlikely to become an issue. National Grid Gas plc and other interested parties, however, continue to monitor and manage the issue within ongoing processes.
Gas Transmission	Increased Temperature	Potential security of supply issues as compressor stations not designed to run at elevated temperatures. Climate change, in itself, is not the only factor. The issue being that units are now being run in a more flexible manner, in order to respond to system demands. This combined with the impact of climate change will cause an issue.	Summer operation of some compressor stations is already an issue, further temperature rises will cause more. There is not a specific limit, as it depends both on the external temperature and the load on the unit.	This is already happening as a result of running some compressor stations in the summer – which were designed to run in the winter only.	With no controls in place, this would cause security of supply issues as some compressors would not be operational at elevated temperatures.	Work is ongoing to monitor affected compressor station cab temperatures. Remedial works are being implemented where required to lessen the effect, refrigeration for example.	This is already occurring, with the increase in ambient temperature, it is expected to become more of a concern. As units and network analysis is undertaken, affected units will either be modified, replaced or the system enhanced in that area. This could be over a significant timescale, and is expected to align with the current asset replacement plans. This work would be undertaken along existing processes.

Business Function	Climate variable (e.g. increase in temperature)	Primary impact of climate change variable (e.g. health)	Threshold(s) above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Potential impacts on organisation and stakeholders	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action is planned
Gas Transmission	Increased Flooding	If compressor stations are affected by flooding they can be bypassed without significant effect to supply. There is, however, a potential for National Grid Gas plc to have serious gas flow issues if one particular station was breached. No supplies would be affected in this unlikely scenario.	The threshold of greater than 1 in 75 years (flooding) for this particular station must be reached simultaneously with extremely high gas flows.	There is an extremely remote chance of the level of flooding required coinciding with the level of demand required to cause a supply issue at this particular site.	If there were no controls put in place, the potential scenario could have significant financial implications to National Grid Gas plc Transmission.	To carry out a Cost Benefit Analysis to consider the best way to mitigate against this scenario.	Security of Supply is generally not considered threatened fr0m this variable

Business Function	Climate variable (e.g. increase in temperature)	Primary impact of climate change variable (e.g. health)	Threshold(s) above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Potential impacts on organisation and stakeholders	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action is planned
Gas Distribution	Increased coastal/river erosion	Potential gas release and local security of supply issue due to damaged pipework caused by loss of protection from ground cover.	These points are monitored and controlled regularly. For climate change to have a major effect on the organisation, coastal and river erosion would have to significantly increase above already experienced levels.	There is limited research in river erosion; however the threshold at which we would be affected is seen as relatively high.	If there were no controls in place, this has the potential to lead to security of supply issues.	Key controls are already in place, are tested periodically as appropriate and are deemed satisfactory. Continue with existing surveillance and investment approach. Increase surveillance following severe weather as per existing procedures	As previously stated it is thought unlikely that the increased effect of river erosion will cause National Grid Gas plc any significant issue above that already being experienced. However, there is an action plan in place to resolve all outstanding river crossing erosion issues. It is thought that this number will increase in the future, however the processes already embedded in the organisation are seen as able to address this risk.
Gas Distribution	Increased Flooding	Loss of control and visibility of pressure reduction stations and associated control systems and telemetry potentially leading to loss of supply	Site specific threshold depending on local conditions	Likelihood depends on location. Over the risk assessment period it is highly likely that some gas pressure reduction sites will be flooded. However if a site is flooded it is highly unlikely that in the short to medium term it will impact on the delivery of gas. It will reduce the visibility and control of a site but gas will continue to	In the short to medium term it is unlikely to adversely impact on the supply of gas. There is a risk that if equipment or communications fail that this might result in the loss of gas to consumers There will be an investment cost to impact for National Grid Gas plc to recover and repair sites after they are flooded. If	Initial assessment already complete and action plan developed. Implement action plan from assessment Reassess	Flooding of National Grid Gas plc assets has already been experienced and managed effectively.

				flow.	mitigation actions are put in place there may be investment costs to protect sites to minimise the risk of flooding or the damage caused by flooding	effectiveness	

Business Function	Climate variable (e.g. increase in temperature)	Primary impact of climate change variable (e.g. health)	Threshold(s) above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Potential impacts on organisation and stakeholders	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action is planned
Gas Distribution	Increase in subsidence/land slip	Potential gas release and loss of supply due to damage lower pressure (<7bar) metallic pipe systems from ground movement caused by subsidence or land slip	Site specific threshold depending on local conditions	Presently mains replacement is ongoing and land slip and subsidence may have an additional impact, further work is required to understand. National Grid Gas plc in agreement with the HSE and Ofgem are replacing all their metallic lower pressure assets (<7bar) that are within 30m of a building by 2031. This will reduce the likelihood of this happening as the replacement polyethylene (PE) is less brittle and so less likely to fracture with ground movement. Further information around the likelihood of future ground movements as a result of climate adaptation is required to better assess this risk	If there is ground movement there is a risk that this will cause lower pressure (<7bar) metallic mains to fracture. This will result in a release of gas. This may result in consumers being off gas for an extended period of time as well as the potential for harm to people and property. It would also require the investment to recover the situation. As part of the agreed replacement programme with the HSE and Ofgem there is an investment cost to National Grid Gas plc to replace their existing metallic lower pressure networks to significantly reduce the risk of asset failure due to ground movement.	Continue with current processes to manage releases of gas Continue mains replacement programme to reduce the risk Monitor any incidents as a result of ground movement and assess if any further actions are required	Further data and analysis is required to better understand the extent to which climate adaptation will cause ground movement and over what timeframe

4.7. BARRIERS TO IMPLEMENTING THE ADAPTATION PROGRAMME

During the work the following barriers have been identified:

Acceptance from stakeholders

There is still a lot of uncertainty around climate change and how quickly or severe it may be. National Grid is fully committed to ensuring that appropriate actions are taken to ensure that its assets and processes are well placed to withstand changes in the climate. However some of those actions may require major investments and these investments have to be justified as necessary and efficient in advance of climate change. There is a requirement for wide acceptance of the likely scenarios that need to be planned and invested for. The current data provided by government through the UKCP09 climate projections contributes towards this acceptance.

In order to ensure that the right investments are made, consideration should be given in the future, to expand the UKCP09 climate projections to cover a wider range of physical characteristics. These can then be used by industry for their assessments and in developing their robust business cases to ensure that the right investments are made.

Interdependencies Including Stakeholders

Some of National Grid Gas plc's assets are on 3rd party structures (e.g. bridges owned by Network Rail, British Waterways etc). National Grid Gas plc has regular dialogue with these 3rd parties as part of its day to day operations and as part of its longer term planning activities. As such, National Grid Gas plc will continue to utilise these existing processes and contacts to better understand the risk of climate adaptation to these 3rd party structures and as a consequence to National Grid Gas's assets. There may be future challenges if National Grid Gas plc believes that additional investments are required and the 3rd party does not but these will need to be addressed in due course.

Supply of Skilled Resource

Skilled resources, particularly technical, is an ongoing concern for many companies. National Grid Gas plc actively seeks to recruit and develop both strategically and tactically. In addition to its normal recruiting programmes, National Grid Gas plc seeks talent through its Internship, Year in Industry, Industrial Placement, Sponsored Student, Graduate and Foundation Engineer programmes. The resource from these programmes also assists to satisfy current business requirements.

External Agencies

A number of National Grid's assets rely on the flood defences or shoreline management plans owned and maintained by external agencies, the Environmental Agency (EA) or the Scottish Environmental Protection Agency (SEPA). To ensure that the adaptation plan is successful, dialogue between these agencies and National Grid are required to ensure these layers of protection are maintained.

- National Grid's duties are to develop and maintain efficient, coordinated and economical networks and facilitate competition in energy supply. While National Grid has discretion concerning the investments that it undertakes in these network businesses to achieve these duties, the revenues that will fund these investments depend on the regulator accepting that such investments are in the interest of present and future consumers

To progress investments which improve the resilience of infrastructure National Grid must establish that future revenues to fund such investments can be secured. In line with the regulatory approach taken by Ofgem to set price controls for a future period, National Grid presents future investment plans for scrutiny by Ofgem in the price control review process in order to secure future funding.

In summary, regulation has a strong influence on capital investment programmes and operational expenditures that National Grid's licensed network businesses can undertake. National Grid will work with Ofgem to achieve a shared view of the potential requirements for adaptation and the associated expenditure that are in the interests of present and future consumers. National Grid's plans for adaptation may depend on obtaining suitable agreement with Ofgem on the associated financial investment plans presented by National Grid. National Grid believes that the current regulatory framework will provide suitable levels of investment.

To improve the long term resilience of new and existing infrastructure a number of barriers and challenges will need to be overcome, these include:

- Maintaining and developing policies, standards and designs for new and existing infrastructure ensuring that the long term impacts of climate change are considered and incorporated

- Incorporating the issue of resilience against climate change into operational business decisions so that monitoring and planning for the impacts become part of core business operations

- Ensuring that the climate change projections, science and impacts are better understood by those in the planning, investment and asset management for infrastructure so that appropriate measures are incorporated into the decision making process

National Grid's network businesses are capital intensive activities and, due to their monopolistic nature, are subject to price controls and efficiency incentives set by the gas and electricity sector regulator Ofgem and its decision making body the Gas and Electricity Markets Authority.

Potential Impacts of Climate Change on Key Stakeholders

For the purposes of the Adaptation Programme, the following sectors / organisations have been identified as National Grid Gas's key stakeholders:

- Department of Energy Climate Change (DECC)
- Office of the Gas and Electricity Markets (Ofgem)
- Health and Safety Executive (HSE)
- Civil Contingencies Secretariat
- Suppliers and Shippers
- Customers
- Department for Environment, Food and Rural Affairs (Defra)
- Cabinet Office
- Welsh Assembly
- Scottish Parliament
- Environment Agency (EA)
- Scottish Environmental Protection Agency (SEPA)
- Met Office
- Independent Distribution Networks (IDNs)
- Local Authorities
- Regional and Local Resilience Forums
- Land owners

In developing adaptation it is important, where appropriate, that plans are co-ordinated with key stakeholders to ensure a consistent and effective approach. For example, it is essential that company plans and Ofgem's plans are in harmony and that supplier's plans will enable companies to deliver any reinforcement or replacement projects that may be required to safeguard the gas system.

Market Adaptation

National Grid Gas plc strives to provide energy through its networks to the end user in the most efficient, environmentally sound and reliable way possible. It is therefore necessary for National Grid Gas plc to continually monitor the changes within the markets and develop the networks to ensure this is delivered.

As a result, although it is essential to research fully the potential effects of climate change in order to understand the potential impacts and mitigations, it is probable that the scale of any network upgrades will be controlled by the change to market demands rather than climate change alone.

National Grid's current policy is to design and build to international standards which by their nature lead to economic and efficient networks. These standards themselves may be changed due to climate adaptation (e.g. maximum operating temperatures for assets) and through their continued use, National Grid Gas plc's assets and networks will continue to be robust to climate change.

Local / Regional Area Mutual Defence Strategies

National Grid recognises the need for local / regional area mutual defence strategies, for example a number of utilities contributing to a coordinated mutual defence scheme rather than defending their own assets in isolation.

However, whilst in most cases this is the correct approach, it is unclear as to how this can be accommodated under the present regulatory frameworks of different utilities, local governments, public and private sectors. Thus there is a need for clear centralised guidance on how these projects should be managed and funded.

Data Changes

National Grid has assessed its assets against current data, but as this data develops and refines the risk to sites can change. National Grid would like to continue to work with stakeholders in developing a method by which changes to data are cascaded to key infrastructure owners.

Addressing the barriers identified

National Grid Gas plc will continue to actively engage with its key stakeholders on climate change adaptation and seek to ensure any potential barriers identified and resolved.

Adaptation risks are assessed through National Grid's risk process and work in addressing these risks will where appropriate lead to policies or standards being revised e.g. National Grid Gas plc has incorporated flood risk assessment into its investment procedure.

National Grid Gas plc will highlight the importance of resilience enhancing investments and operational measures in its business plans to its regulator and thereby seek to secure suitable financing revenues.

4.8. REPORT AND REVIEW

Monitoring the Adaptation Programme

The risk assessment process has been valuable in enabling a central view of the risks identified in the process. How these risks are managed will depend on the result for the initial assessment.

The individual risks are managed through the National Grid risk process and the timescales are managed through the risk review process. National Grid Gas plc's overall adaptation strategy is kept under continuous review by the central Climate Change team. Updates are given annually to the Executive and also the Risk and Responsibility Committees.

Where the risk was identified as being green, it is deemed that at this stage no further action is required and the risks will be refreshed at the next reporting period with the latest available climate data.

Where the risk was identified as yellow, it has been fully written up as part of National Grid's on going corporate risk reporting process. This means that the risk is fully assessed, has mitigation actions with delivery deadlines as well as risk owners. Part of the corporate reporting process means that the risk is reviewed every quarter ensuring that there is the appropriate management focus to ensure that actions are progressed and completed in a timely fashion.

Where the risk was identified as being amber, actions have been or are being identified for the current reporting period to quantify the actual risk and develop an action plan if required.

For some of the amber risks, the actions will require ongoing monitoring until sufficient information is available to understand the risk. This may not be immediately available and mean that they remain amber into the next reporting period.

If the risk was identified as being Red, there is a high probability or significant, material risk in the future. Current business processes and action plans do not adequately address this specific risk and require a further full risk assessment and action plan to be developed commensurate with the risk.

Due to the main risks identified, the thresholds of concern are likely to be local thresholds. Where appropriate these thresholds will be monitored locally and appropriate action taken. For example where a river to encroach on a pipeline asset, this will be identified by regular monitoring of pipelines and an investment would be sanctioned to protect the pipeline asset.

The benefits of the programme are focused around National Grid ensuring that it is prepared for climate adaptation and making the appropriate preparatory investments to safely manage any increased risks to climate adaptation. The quarterly risk review process will ensure that the appropriate actions are being taken forwards and as part of the next reporting cycle National Grid will review the effectiveness of the process that it has outlined and implemented as a result of this direction.

The approach has been designed to ensure flexibility has been maintained in the programme by categorising the risks as green, yellow, amber and red. This has allowed the response and actions to a risk to be proportionate to the evidence and certainty that is available at any moment in time. As new information becomes available it will be possible to quickly reassess the risks and update the response as appropriate. It is anticipated that this approach will ensure that essential investments are made in a timely manner but also enable close management of investment in areas of greater uncertainty.

Monitoring the Thresholds above which Climate Change impacts will Pose a Risk to the Company and Incorporation into Future Risk Assessments

National Grid Gas plc in conjunction with energy companies has commissioned work with the Met Office via the EP2 and "Climate risk assessment on future network resilience" which use published

UKCIP02 and then UKCP09 data. These projects assess if the current published climate change thresholds pose a risk to the company.

National Grid Gas plc has embedded this work into this Adaptation Report which is legally required to be updated every 5 years. Therefore when new climate change data is published or the Adaptation Report is due for renewal any changes in published climate change data will be reviewed and any thresholds which increase and thus potentially cause a risk will be added to the National Grid Gas plc risk register.

Monitoring the Residual Risks of Impacts from Climate Change in the Company

The assessment of climate change risk is embedded into the National Grid Gas plc risk process, and ultimately results in changes in policies and procedures where required. National Grid has processes in place to monitor legislation changes and changes to industry policy and procedures such that the policies and procedures within National Grid Gas plc can be reviewed and updated.

4.9. RECOGNISING OPPORTUNITIES

This process has reinforced the requirement to coordinate risk assessment processes with relevant third party stakeholders and has identified the requirement for further research and collaborative work between government, agencies and industries to better understand potential climate change related scenarios and their impacts

Adaptation reporting has provided the opportunity for National Grid to assess and demonstrate the resilience of its networks that may otherwise caused concern to stakeholders. It also provides a documented foundation on which to have a more informed and focused debate on the risks of climate change.

4.10. FURTHER COMMENTS / INFORMATION

The climate change assessment would be more effective and robust if peak values rather than increments were given as part of the UKCP09 characteristics, e.g. a statement such as "the peak temperature will reach 50°C" rather than "the peak temperature will increase by 8 C".

National Grid is concerned that adaptation reporting may duplicate some of the current guidance that companies already have for internal reporting (e.g. carbon budgets), country level regulatory reporting (e.g. EU ETS, CRC).

National Grid welcomes the work undertaken by the Met Office at Hadley Centre and has been active in supporting some of this work as part of an Innovation Funding Incentive supported project, managed by the Energy Networks Association. This was an industry funded project working to understand precise requirements and develop practical applications and business strategies for a changing world. An understanding of the potential effects of climate change and network resilience will assist National Grid Gas plc making long term infrastructure decisions.

National Grid Gas plc manages critical national infrastructure and welcomes research which can be applied to its business that can improve its performance. National Grid Gas plc actively supports various research programmes, for example Mark Fairbairn, Executive Director is a member of the “Living with Environmental Change” programme. We are also involved in the Engineering and Physical Sciences Research Council Supergen portfolio.

National Grid Gas plc is also very supportive of Ofgem’s Low Carbon Network Funding initiative and would welcome involvement in this and related projects.

In addition National Grid’s R&D strategy is to develop knowledge and technology focussed on reducing its environmental and climate change impacts. National Grid has funded over £1m of research on weather and climate change related projects through the Innovation Funding Incentive since April 2007, both directly and in collaboration with other utilities and manufacturers. (Combined funding over £10m).

4.11. OVERALL SUMMARY & CONCLUSIONS

National Grid Gas plc has found the opportunity to report to Defra its risk assessment of adaptation to Climate Change a valuable process. As part of its normal business operations many of the risks from climate adaptation had already been identified and managed, this process has brought all of those together to give a single view across our gas transmission and distribution businesses assessed against the projected climate change scenarios.

National Grid developed a process based on using Specific Physical Characteristics. These were developed against the high level scenario which is based on the least likely to occur prediction of climate change as of 2080. This was on the basis that if National Grid's assets and processes should demonstrate resilience against this scenario they would inevitably be adapted against lower and more likely climate change outcomes. These characteristics were developed with the aim of allowing greater focus on key risk areas, using data from the UKCP09, the Met Office and National Grid Gas plc's engineers and are summarised below:

- Summer Mean temperature rise of up to 8^{o}C
- Increased heavy rainfall (by a factor of up to 3.5)
- Sea Level rises of up to 43cm
- Increased lightning
- Increased Wind and Gale
- Increased Snow, Sleet, Blizzard, Ice and freezing fog
- Increased flooding
- Increased coastal/river erosion
- Increased subsidence

Each of these characteristics were assessed against the key assets and processes for National Grid Gas plc . The initial risk assessment had four outputs: green –no material risk, yellow – a currently controlled risk, amber – a risk requiring further information, red – a significant and not currently controlled risk.

The results showed that for National Grid Gas plc there were no red risks identified, and there were a significant number of greens; highlighting the resilience of the networks. There were a varying number of yellows and ambers for Transmission and Distribution, showing that despite a significant degree of resilience, that the energy infrastructure may be vulnerable to certain aspects of climate adaptation on a localised scale and that further work is required to understand, manage, and mitigate these risks. For the ambers there are action plans in place to better understand the risks in future and for the yellows a more detailed risk assessment has been completed and action plans identified to mitigate the risks to their target level.

The key findings of the analysis were as follows:

- As the majority of National Grid Gas plc's assets are underground they are naturally protected from the majority of effects of climate change. As these assets are critical energy delivery assets a high degree of general resilience is built into them and the processes they are managed under and this helps to mitigate any impacts that could be experienced as a result of climate change.

- The key risks that National Grid Gas plc needs to manage as a result of the risk assessment are:
  a. Ground movement fracturing on its ageing low pressure network assets
  b. River erosion
  c. Flooding of critical sites
  d. Temperature rises for Transmission compressor stations
  e. Assets located which are reliant on 3rd parties structures (e.g. bridges).

- Although both the Transmission and Distribution networks show a high degree of resilience it can be seen that there is greater resilience built into the Gas Transmission network compared to the Gas Distribution network. This is to be expected due to the critical national impact of the Transmission network compared to the more localised impact of the Distribution network.

- Through National Grid Gas plc's asset management processes the material risks are being managed and regularly monitored through existing business processes. In many cases the risks have already been experienced and mitigation measures are in place to manage any increase in severity of the risks as a result of further climate adaptation. This may require a significant increase in mitigation investment in the future.

National Grid Gas plc acknowledges that climate adaptation is an evolving science and it is envisaged that the flexible approach that has been adopted will allow for risks to be reassessed as further information becomes available. National Grid Gas plc found the UKCP09 information invaluable in completing its analysis, but has highlighted areas where additional information would be useful in future particularly around the following Specific Physical Characteristics: Increased lightning, wind and gale, snow, sleet, blizzard, ice and freezing fog and increased subsidence. It would also be helpful for future data to include absolute values or ranges as well as any incremental values from historic trends.

In conclusion, the analysis and results have demonstrated that National Grid Gas plc is well placed and in a good state of preparedness as assessed against future anticipated climate change scenarios. It has a good understanding of the risks of climate adaptation and that the management of these risks is already at an advanced stage of being embedded into the normal day to day business risk processes. This ensures that these risks are regularly reviewed and updated with appropriate actions and targets.

5. APPENDICES

A. DEFINITIONS AND GLOSSARY OF TERMS

Our aim is to use plain English in this report. However, where necessary, we do use a number of terms and or abbreviations and we summarise the principal ones below, together with an explanation of their meanings. The definitions are not formal legal definitions.

A - D

Above Ordinance Datum (AOD)
Used by an ordnance survey as a basis for deriving altitude on maps usually mean sea level (MSL) is used for the datum

British European Standard Specification (BS EN)
British Standards are the standards produced by BSI Group.

British Standards Institution (BSI)
Services provider whose principal activity is the production of standards and the supply of standards-related services.

Civil Contingencies Secretariat
Department of the British Cabinet Office responsible for emergency planning in the UK.

COMAH
Control of Major Accident Hazards Regulations (1999) and Control of Major Accident Hazards (Amendment) Regulations (2005) is aimed at preventing and mitigating the effects on people and the environment of those major incidents involving dangerous substances.

Customer
A person to whom gas is provided.

Department of Energy Climate Change (DECC)
Government department which brings together energy policy and climate change mitigation policy.

E – H

Energy Networks Association (ENA)
Represents the interests of its member companies who operate the national and regional networks for energy to transport gas and electricity into UK homes and businesses.

Energy Act 2010
Implements some of the key measures required to deliver DECC's low carbon agenda.

EP1 / EP2
ENA initiated Met Office study to investigate the potential impact of climate change. The project was split into EP1 customer requirements and scoping which was completed in 2006 which facilitated the EP2 project which assessed the risk of climate change on the UK's energy industry this report was published in 2008.

Engineering Technical Report ETR138
ENA technical report which provides guidance on flood risk assessments.

Gas and Electricity Markets Authority
Ofgem decision making body.

GDN
Gas Distribution Network. The UK's gas distribution system is split into eight geographical networks. National Grid Gas owns and operates four of these.

GS(M)R
Gas Safety (Management) Regulations (1996), which are part of health and safety legislation, set the legal parameters for gas entering into and leaving the GB gas network.

GT License
The Gas Transporters Licence sets out the regulatory conditions which must be met by the regulated business, including levels of service, funding mechanisms, investment and operating obligations.

Health and Safety Executive (HSE)
HSE is the national independent watchdog for work-related health, safety and illness. An independent regulator and act in the public interest to reduce work-related death and serious injury across Great Britain's workplaces.

I – L

IDN
Independent Distributions Networks are the GDNs that are not owned and operated by National Grid Gas

IGT
Independent Gas Transporter

Institute of Gas Engineers and Managers (IGEM)
Aims to be the pre-eminent Institution for gas professionals across the world by promoting professional competence, co-ordinating gas policy and supporting professional development.

LDZ
Local Distribution Zone

LNG
Liquefied Natural Gas, natural gas is cooled to around -160 ℃ so that it can be stored and transported as a liquid. As a liquid, natural gas takes up 600 times less space than in its gaseous form.

Isle of Grain
An unregulated subsidiary of National Grid. The Isle of Grain is a Liquefied Natural Gas importation terminal.

LNG Storage Facility
These are part of National Grid Gas plc's Transmission network and as such are a regulated part of the business. These store LNG and can inject natural gas into the network when demand is high.

M – P

Met Office
The UK's National Weather Service.

NTS

The National Transmission System. This is the gas transmission system in Great Britain that is owned and operated by National Grid.

Office of the Gas and Electricity Markets Ofgem
Protecting consumers by promoting competition, wherever appropriate, and regulating the monopoly companies which run the gas and electricity networks.

Pitt Review
An independent review of the flooding emergency that took place in June and July 2007.

PASS55
PAS 55 is the British Standards Institution's (BSI) Publicly Available Specification for the optimized management of physical assets.

Planning Policy Statement 25 (PPS25)
Sets out the Government's spatial planning policy on development and flood risk.

PSR
Pipeline Safety Regulations (1996) provide for the management of pipeline safety and apply to all pipelines in Great Britain.

Q – T

Regional and Local Resilience Forums
Deals with emergency preparedness, response and recovery as directed by government implemented at a regional and local level.

Scottish Environmental Protection Agency SEPA
Scotland's environmental regulator similar to the Environment Agency in England and Wales.

Shoreline Management Plans
A large-scale assessment of the risks associated with coastal processes coordinated by the Environment Agency.

U - Z

UK Climate Impacts Programme 2002 (UKIP02)
Climate change scenarios derived from a series of climate modelling experiments commissioned and funded by Defra, undertaken by the Hadley Centre and analysed by the Tyndall Centre.

UKCP09
Provides future climate projections for land and marine regions, and observed climate data.

UNC
The Uniform Network Code (UNC) is the hub around which the competitive gas industry revolves, comprising a legal and contractual framework to supply and transport gas. It has a common set of rules for all industry players, which ensure that competition can be facilitated on level terms. It governs processes, such as the balancing of the gas system, network planning, and the allocation of network capacity.

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B. GAS INDUSTRY DESIGN STANDARDS

This appendix provides some background on the most relevant applicable design standards, together with some illustrations relating to the historical usage of older British Standards in a global context.

Whilst present day Standards are dominated by those issued by the Institute of Gas Engineers and Managers (IGEM) and European Norms (EN), it should be recognised that much gas network infrastructure still in use was designed according to British Standards issued many decades ago. It is thus appropriate to briefly describe the climatic conditions used as the basis for equipment ratings in those old Standards.

UK Gas Transmission has a number of electrical assets for example large electric drives, hence there is some crossover of the key design standards used in Electricity Transmission. A number of key design standards used in the UK Gas Transmission are detailed below.

Standard etc	Date	Title	Comment on climate content
IGE/TD/1		Steel pipelines for high pressure gas transmission.	Design guidance for pipeline construction for operation at temperatures between -25 ℃ and +120 ℃. Our system constrained generally to operation below 50 ℃ due to compressor operation.
IGE/TD/13		Pressure regulating installations for transmission and distribution.	Design guidance for AGI construction for operation at ambient temperatures between -20 ℃ and +60 ℃. In excess of ambient temperatures anticipated and in general operation constrained to 50 ℃ operation due to compressor operation.
ASME B31.3		Process piping	Used for design of some AGIs and compressor stations. Has been used to design systems for use up to at least 50 ℃.
ASME B31.8		Gas transmission and distribution piping systems.	Used for design of some AGIs and compressor stations. Has been used to design systems for use up to at least 50 ℃.
IEC 60694	2002	Common specification for switchgear and control gear (superseded by BS EN 62271-1)	- sets ambient temperatures, pollution etc. E.g. outdoor equipment for –minus 25 ℃ and 10 mm ice coating. Also sets lightning overvoltage performance levels The ambient air temperature does not exceed 40 ℃ and its average value, measured over a period of 24 h, does not exceed 35 ℃
IEC 60947	2007	Low Voltage switchgear and Control Gear	Ambient not greater than 40 ℃ and its average value, measured over a period of 24 h, does not exceed 35 ℃
IEC 60265-1	1998	HV switches for rated voltages 1 kV to less than 52 kV	
BSEN 62271-200	2005	A.C. metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV	Links to 60694 The ambient air temperature does not exceed 40 ℃ and its average value, measured over a period of 24 h, and does not exceed 35 ℃. Minimum minus 5 ℃ indoor minus 25 ℃ outdoor

It should be noted that the list does not include all design standards used in UK Gas Transmission.

C. REFERENCES AND LINKS

National Grid 10 Year Statement
http://www.nationalgrid.com/uk/Gas/TYS/

National Grid Long Term Development Plan
http://www.nationalgrid.com/uk/Gas/TYS/LTDP/

National Grid Annual Report 2010
http://www.nationalgrid.com/corporate/Investor+Relations/Reports/

Institute of Gas Engineers and Managers (IGEM)
http://www.igem.org.uk/

UKCP09
http://ukclimateprojections.defra.gov.uk/content/view/12/689/

British Standards Institution (BSI)
http://www.bsigroup.com/

Office of the Gas and Electricity Markets Ofgem
http://www.ofgem.gov.uk/Pages/OfgemHome.aspx

Department for Environment, Food and Rural Affairs (Defra)
http://www.defra.gov.uk/

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D. NATIONAL GRID CLIMATE CHANGE ADAPTATION REPORTING PROCESS

This appendix explains the process that National Grid developed and followed to complete the Climate Change Adaptation Risk Assessment. It was designed to give a high level overview of all the risks across the business and then focus effort on the areas where the risks are more significant.

There are six stages to the process:

Stage 1 – Develop Scenarios for National Grid's Climate Change Adaptation Risk Assessments and Planning

These scenarios are based on the UK Climate Projections 09 work and build on the work done with the UK Climate Projections 02. A scenario has been chosen inline with the scenarios for 2020, 2050 and 2080 timeframes. All of these timeframes are relevant due to the long asset lives of the infrastructure that National Grid invests in. Further details on the scenarios can be found at http://ukclimateprojections.defra.gov.uk/. For each data point the greatest or lowest regional value has been taken to represent the UK. The range of results in the scenarios has been included in square brackets to give a perspective on the variance. All numbers are compared to the values for 1961 to 1990. To be consistent with our asset management approach we have used worst case scenarios.

Three selected scenarios:

1. 2020 Scenario is based on UK Climate Change Projections 2020 High Emissions Scenario at 90% confidence rating.
2. 2050 Scenario is based on UK Climate Change Projections 2050 High Emissions Scenario at 90% confidence rating.
3. 2080 Scenario is based on UK Climate Change Projections 2080 High Emissions Scenario at 90% confidence rating.

Details of these scenarios can be seen in the Table D1.

Table D1: Scenario details

	Scenario 1	Scenario 2	Scenario 3
Scenario Characteristic	**1: 2020 Scenario 90th percentage [wider range]**	**2: 2050 Scenario 90th percentage [wider range]**	**3: 2080 Scenario 90th percentage [wider range]**
Change in mean winter temperature (ºC)	+2.2^{o}C [+0.1 to 2.2 ^{o}C]	+3.8^{o}C [+0.6 to 3.8 ^{o}C]	+5.7^{o}C [+0.9 to 5.7%]
Change in mean summer temperature (ºC)	+2.7^{o}C [+0.4 to 2.8 ^{o}C]	+5.2^{o}C [+0.8 to 5.2 ^{o}C]	+8.1^{o}C [+1 to 8.1 ^{o}C]
Change in mean winter precipitation (%)	+20% [-5% to +20%]	+41% [-2% to+41%]	+73% [-4% to +73%]
Change in mean summer precipitation (%)	+22% [-31% to +22%]	+11% [-50% to +20%]	+6% [-65% to +15%]
Relative sea-level changes (cm) with respect to 1990 levels	+11.5cm [+4.6 to 11.5cm]	+25.9cm [+11.1 to 25.9cm]	+43.3cm [+18.6 to 43.3cm]
Number of days with heavy rain (>25 mm) - Central estimates are for heavy rain days (rainfall greater than 25 mm) over most of the lowland UK to increase by a factor of between 2 and 3.5 in winter, and 1 to 2 in summer by the 2080s under the medium emissions scenario.			

Stage 2 – Convert Climate Change Scenarios into Specific Physical Characteristics

To better understand the potential impacts and associated risks that these Climate Change Scenarios pose on National Grid's assets they have been converted into key Specific Physical Characteristics. To help do this additional information has been taken from the Met Office's work on Climate risk assessment on future network resilience and combined with National Grid's own thinking.

The result has been to identify Specific Physical Characteristics that are likely to be caused by these scenarios, and it is the impact of these characteristics to National Grid's key assets and processes that is risk assessed. The Physical Characteristics can be broken down into three groups:

1. The first are directly correlated to the UK Climate Projections 09 work and so have greater definition and probabilities around them are known as the UKCP09 Characteristics.
2. The second are taken from work that the Met Office has done and are known as MO Characteristics.
3. The third are additional characteristics added by National Grid to ensure that the main key risk areas are covered, these are known as National Grid Characteristics.

For the final two groups, although these characteristics are anticipated to be caused as a result of climate change, further work will be required to assess any expected increases in magnitude and the associated probabilities.

The Specific Physical Characteristics can be summarised as follows:

UKCP09 Characteristics

- **Summer Mean temperature rise of up to 8.1 ℃** – This corresponds to the mean summer temperature rise of 8.1 ℃ by 2080 in the scenario. This effect is likely to be geographically specific and the greatest effects would be seen in urban heat islands.
- **Increased heavy rainfall (by a factor of up to 3.5)** – based on the analysis in the UKCP09 projections that heavy rain days (>25mm/day) were likely to increase by up to a factor of 3.5 by 2080.
- **Sea level rises of up to 43 cm** – based on the analysis in the UKCP09 projections sea levels may rise by 43.3cm by 2080.

Met Office Characteristics

- **Increased lightning** – increased intensity, frequency and geography of cloud to ground lightning strikes expected
- **Increased Wind and Gale** – increased wind and gusts expected, including potential changes in direction
- **Increased Snow, Sleet, Blizzard, Ice and freezing fog** – increased snow fall, ice, frost and freezing fog
- **Increased flooding** – due to increased rainfall intensity, frequency and geography of flooding is expected to increase

National Grid Characteristics

- **Increased coastal/river erosion** – due to increased rainfall and storms it is anticipated that there will be increased erosion of coastal defences and river banks
- **Increased subsidence** – due to increases in rainfall and greater anticipated seasonal swings it is anticipated that land subsidence will become a great issue.

Converting the scenarios, into Specific Physical Characteristics, does initially remove the dependence on the timeframes of 2020, 2050 and 2080. However, what it allows is a broad brush approach which if no issues are identified in the risk assessment then there should be no problems out to 2080 based on the currently best available information. For each of the specific risks where issues are identified there is an opportunity to look at the impact overtime.

Stage 3 – Identify National Grid Gas plc's Key Assets and Processes that could be impacted by the Climate Change Scenarios and Specific Physical Characteristics

In this stage, the key assets and process that could be impacted by Climate Adaptation and the Specific Physical Characteristics are identified. These will be different for each business.

The key asset types to assess these against were identified starting with the PAS55 asset types. For National Grid Gas plc Transmission these were:

- The National Transmission System (70 - 94 barg system)
- The NTS river crossings
- Gas Terminals
- Compressor Stations
- Liquefied Natural Gas (LNG) Storage Facilities
- Above Ground Installations (AGIs)

These assets are critical to delivering National Grid Gas plc Transmission's business objectives. NTS river crossings have been identified as a separate asset as they are subject to a number of different environmental factors than the rest of the NTS. It was felt that by separating them from the rest of the NTS a more robust risk assessment could be completed for both asset types.

For National Grid Gas plc Distribution, the following assets were identified:

- The Local Transmission Systems (above 7barg system);
- The Distribution System;
- PRIs
- Control Systems and Telemetry

Gas holders have not been included as part of the assessment as they are currently all within a decommissioning strategy and are all scheduled to be removed from the network during the risk assessment period. Should any of them become inoperable, National Grid Gas Distribution has planned contingencies that would protect the supply of gas to consumers.

National Grid Gas's key processes that support the installation, operation and maintenance of these assets as well as protecting public safety are:

- Emergency
- Maintenance
- Investment and Repair
- Control Centre Operations
- Office staff (including call centres)

Stage 4 – High Level risk assessment of the impact of the Physical Considerations on the Key Assets and Processes

This process applies the Specific Physical Characteristic, one at a time, to each of the Key Assets and Processes. It then assesses if result will have an impact on the public from a safety or security of supply perspective.

This analysis has three potential outcomes that are identifies using a traffic light approach:

Green No material risk to assets or processes from the Specific Physical Characteristic. This is either because no risk has been identified or the existing assets or processes are robust and no further action is required in terms of adaptation measures.

Yellow A level of risk has been identified through the risk assessment. Action plans have or are being developed and progress is being monitored via the risk and compliance process, it may be that additional investment will be required to manage these risks. The impacts of these risks have been further assessed using National Grid's risk management process.

Amber Insufficient information is currently available on the affects of the Specific Physical Characteristic to calculate the level of risk. Further monitoring or assessment will be carried out to better understand this risk as more information becomes available

Red Highly likely or significant, material risk in the future. Current business processes and action plans do not adequately address this specific risk. Full risk assessment and action plan to be developed.

Appendix E shows the summary tables produced from this process.

Stage 5 – Actions and Monitoring developed for amber items

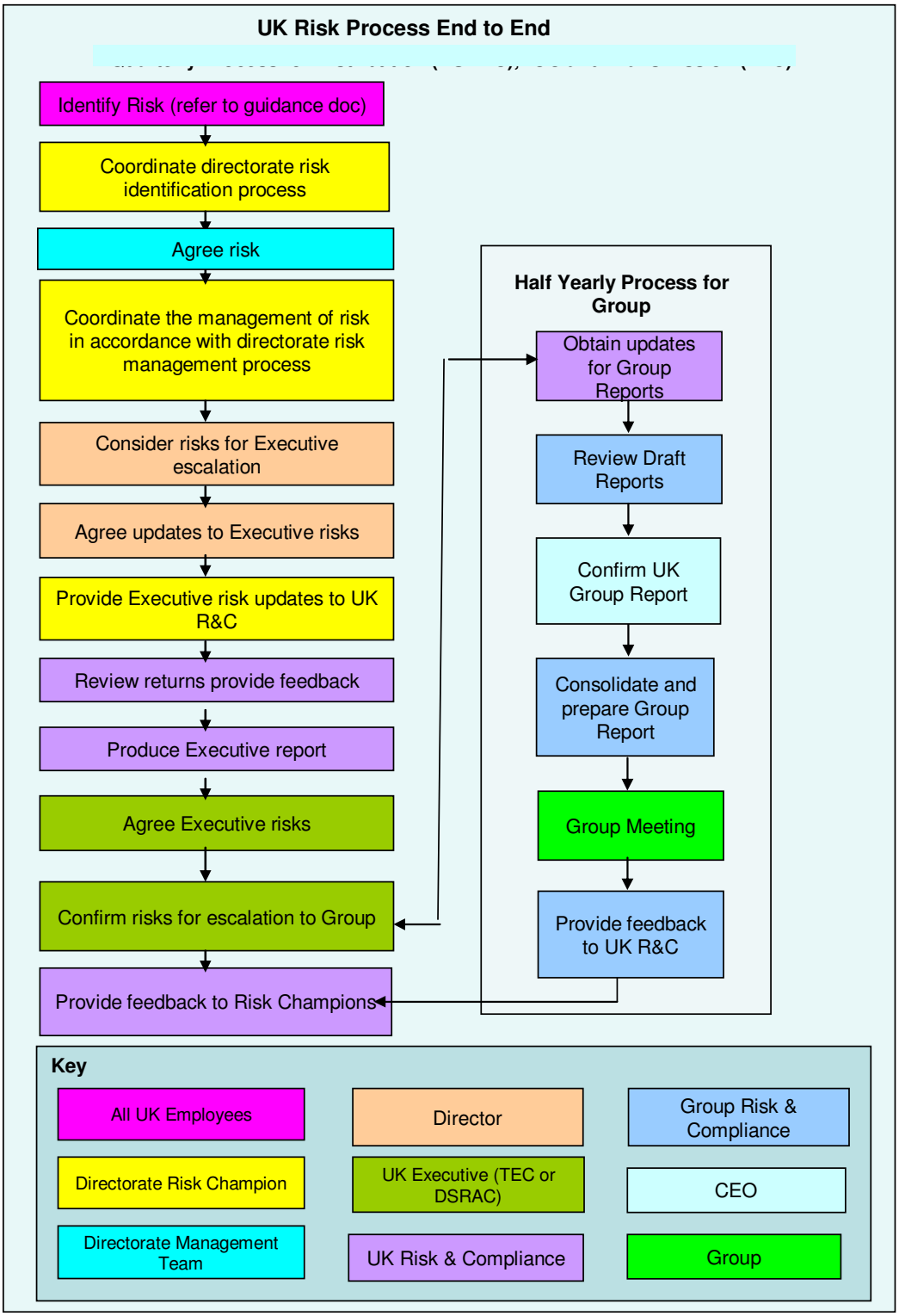
For items that were identified as amber, there was a degree of uncertainty in the level of risk that required further action on monitoring to enable that risk to be better understood in future. For each of the amber risks, an action plan is developed with an owner in the business. These action plans are held within working documents at National Grid.

Stage 6 – Detailed risk assessment and action plan/mitigation actions for red and yellow risk areas.

This is the final stage of the assessment where risks that were identified as yellow or red are assessed in more detail according to National Grid's business risk assessment process. The aim of this is to better quantifying the risks. Each risk will have details of the existing controls and actions for moving the current risk rating towards a target risk rating with owners for each of the actions.

A summary of National Grid's risk management and review process can be seen in Figure D2.

Table D2: summary of National Grid's risk management and review process



E. ADAPTATION RISK ASSESSMENT RESULTS FURTHER DETAIL

Table 5.B.1 Detailed Risk Assessment for National Grid Gas plc Transmission

Key Assets and Processes	Specific Physical Characteristics of Climate Adaptation Scenarios									
	UKCP09 Characteristics			Met Office Characteristics				NG Characteristics	
Included in National Grid's Risk Management Process	Solar Heat - Temperature rise of up to 8°C	Increased heavy rainfall (by a factor of 2-4)	Sea level rises of up to 43cm	Increased lightning	Wind and Gale	Snow, Sleet, Blizzard, Ice and freezing fog	Increased flooding	Increased coastal/river erosion	Increased subsidence
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Assets									
National Transmission Pipework (~70 barg)	Pipework is buried which therefore significantly reduces any increases in temperature	Pipework is buried and is therefore not impacted by increased heavy rain [note flooding risk]	Pipework is buried and is therefore not impacted by an increase in sea level.	Pipework is buried and is therefore not impacted by increased lightning	Pipework is buried and is therefore not impacted by increased wind and gale	Pipework is buried and is therefore not impacted by increased snow, sleet and blizzard etc.	There is the potential for pipework to float if the ground above it is fluidised by flood waters.	Assets are already protected by robust monitoring process and investments will be made if required. Risk of increased erosion will be managed by existing processes.	Subsidence is monitored and assessed. The network is regularly inspected by helicopter.
River Crossings	Asset buried and under water, impact of increased temperature will be minimal	Increased heavy rainfall may increase erosion to river bed/bank. Covered separately	Sea level rises will have minimal impact on river crossings	Increased lightning will not affect river crossings	Increased wind and gale will not affect river crossings	Snow, sleet, blizzards etc. may impact river bank/bed erosion. Covered separately	This will impact upon river bed/ban erosion. Covered Separately	Climate change may accelerate river bed/bank erosion. This is a process that is already being managed. There is one crossing that has been identified as an issue - this is being remedied	Subsidence is monitored and assessed. The network is regularly inspected by helicopter.
Compressor Stations	Compressors are being used in the summer - not what they were designed to do	Increased heavy rainfall does not pose an issue with the operation of compressor sites. [note flooding risk]	Potential that low lying compressor stations may be affected by increase in sea level.	Compressor stations are fitted with standby generators and protected against lightning strikes.	There is the potential that with increased wind, there may be excess loadings expected on existing assets.	Potential for freezing fog to cause blockages in gas turbine air intake filter. Causing high differential pressure trip, this can be managed.	There is only one site currently at risk from flooding, this is not a risk security of supply.	Compressor Stations not by coast except where within a Terminal. (Reference Terminals)	Subsidence is monitored and assessed where appropriate.
LNG Storage Facilities	Increased temperature may reduce liquefaction efficiency but will not have a detrimental affect on security of supply or safety.	Increased heavy rainfall does not pose an issue with the operation of LNG storage facilities [note flooding risk]	LNG Storage Facilities are not on the coast and so will not be affected by sea level increases.	LNG storage facilities are fitted with lightning protection and standby generation	There is the potential that with increased wind, there may be excess loadings expected on existing assets.	Increased extreme cold weather conditions will not affect the operation of the LNG storage facilities	LNG sites have been assessed for flooding risk. There is currently no risk to the sites.	N/A - Asset not on coast	Subsidence is monitored and assessed.
Above Ground Installations	The operation of AGIs will not be affected by increases in temperature.	The operation of AGIs will not be affected by increased heavy rainfall. [note flooding risk]	Potential that low lying AGIs may be affected by increase in sea level.	AGIs are fitted with Uninterruptible Power Supplies in case external electricity supply failure. Increased lightning will have no other affect on the operation.	AGIs are not adversely affected by an increase in wind and gale conditions.	The operation of AGIs will not be affected by increased snow, sleet, etc.	This will not adversely effect security of supply.	Climate change may accelerate river bed/bank erosion, this could potentially affect AGIs associated with river crossings. This is a process that is already being managed.	Subsidence is monitored and assessed. The network is regularly inspected by helicopter.
Gas Terminals	The operation of terminals will not be affected by increases in temperature.	Operation of gas terminals will remain unaffected during periods of heavy rainfall. [note flooding risk]	Gas terminals are located by the coast by nature of their duty.	Gas terminals are fitted with standby generation in case external electricity supply failure. Increased lightning will have no other affect on the operation.	There is the potential that the wind loadings that any assets were designed against will no longer be applicable.	The operation of Gas Terminals will not be affected by increased snow, sleet, etc.	Currently all terminals are either not at risk of flooding or adequately protected by EA/SEPA defences.	All terminals on the coast. English terminals are defended by EA coastal management plan. Scottish terminal managed by site	Subsidence is monitored and assessed.
Processes									
Emergency	Increased temperatures should not adversely impact our ability to deliver an emergency service	Increased rainfall should not adversely impact our ability to deliver an emergency service [note flooding risk]	Increased sea level should not adversely impact our ability to deliver an emergency service [note flooding risk]	Increased lightning will not affect our ability to respond to emergencies.	Increased wind and gale will not affect our ability to respond to emergencies.	Extreme Snow, Sleet, Blizzard, Ice and Freezing fog may make it difficult to access sites where there are emergency situations. Emergency tactical solutions will be deployed if required.	Flooding may make it difficult to access sites where there are emergency situations to be dealt with, emergency tactial solutions will be deployed if required	N/A - This will not affect emergency response	N/A - This will not affect emergency response
Maintenance	Changes in weather may impact on working practices. Work should still be able to be completed but there may be increased costs	Heavy rain may hamper time taken to complete work. Deferral processes in place. [note flooding risk]	Sea level rises should not adversely affect the ability to complete maintenance on the sites.	While maintenance may be put off during storms, there is a deferral process in place.	Increased wind may affect the ability to do line checking from a helicopter. However a deferral system is in place and the lines can be checked on foot at ground level.	While maintenance may be put off during storms, there is a deferral process in place.	There will be no maintenance during a flood condition - following a flood extra maintenance will be required. This will not pose a risk to safety or security of supply.	N/A - This will not affect maintenance activities	N/A - This will not affect maintenance activities
Investment, Construction and Repair	Changes in weather may impact on working practices. Work should still be able to be completed.	Heavy rain may hamper time taken to complete work. Deferral processes in place. [note flooding risk]	Any investment will first take account of location and not build anything by the sea unless it is protected against sea level rises.	Increased lightning will not affect our ability to deliver investment. It may hamper time to complete construction work.	Any future construction work will be designed to withstand a specified wind loading. Wind loading specifications may need to be reviewed if there is any evidence of increased wind speeds.	Snow and blizzard will not affect our ability to deliver investment. It may hamper time to complete construction work - this is not a risk to safety or security of supply.	Any future investment and construction will firstly take account of location and assess against potential flood hazards - this is not a risk to safety or security of supply	This may result in gas lines being isolated for repair, thus impacting on future investment work, this is not a risk to safety or security of supply	This may result in gas lines being isolated for repair, thus impactirg on future investment work.
Control Centre Operations	Increased temperatures should not adversely impact our control centre operations, this is not a risk to safety or security of supply	Increased rainfall should not adversely impact our control centre operations. [note flooding risk]	Control Centre sites are not located near the sea and so will not be impacted by sea level rises of up to 43cm	There is a risk that telemetry links could be lost between sites. On the majority of sites telemetry is via satellite with an ISDN backup. GNCC have a procedure on responding to a site with a loss of communication.	There is a risk that telemetry links could be lost between sites. On the majority of sites telemetry is via satellite with an ISDN backup. GNCC have a procedure on responding to a site with a loss of communication.	There is a risk that telemetry links could be lost between sites. On the majority of sites telemetry is via satellite with an ISDN backup. GNCC have a procedure on responding to a site with a loss of communication.	There is a risk that telemetry links could be lost between sites. On the majority of sites telemetry is via satellite with an ISDN backup. GNCC have a procedure on responding to a site with a loss of communication.	N/A - This will not affect emergency control centre operations	N/A - This will not affect emergency control centre operations
Office staff (including call centres)	Increased temperatures should not adversely impact our office based operations	Increased rainfall should not adversely impact our office based operations [note flooding risk]	Key Office sites are not located near the sea and so will not be impacted by sea level rises of up to 43cm.	Increased lightning will have no affect on office staff.	Business continuity plans are in place. Relevant staff have the capability of working from home if they can not get to the office.	Business continuity plans are in place. Relevant staff have the capability of working from home if they can not get to the office.	Business continuity plans are in place. Relevant staff have the capability of working from home if they can not get to the office.	N/A - This will not affect office staff	N/A - This will not affect office staff